REFUSE DISPOSAL AND POWER PRODUCTION

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REFUSE "STEAM BOILER APPLIANCES"
ETC ETC

WITH NINETY-EIGHT
ILLUSTRATIONS

WESTMINSTER
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PREFACE

THE production of power from refuse is essentially a modern development most of the Destructors combined with Electricity and Sewage Works having been erected within the past three years In the main, this is my explanation for undertaking the preparation of this work, which has involved a considerable amount of labour Having been responsible for a work[1] on "Refuse disposal" published rather less than three years since I feel that an explanation is due to the reader

It has been my endeavour to place sanitation in the forefront as the primary object of the Destructor, and although the power derived is such a valuable asset, yet we must recognize the Destructor as a sanitary necessity, whether the power can be fully utilized or not

There can be no doubt that the disposal of refuse by the agency of fire has become increasingly interesting to both the lay and professional mind by reason of the very satisfactory amount of power now produced therefrom

This progress will probably not commend itself to the ultra-sanitarian, as being altogether satisfactory, and there are some who deplore the commercial—or power aspect of the question They would have refuse destroyed everywhere, whether power was available or not

From a strictly sanitary point of view, their contention is correct, but seeing that the most perfect cremation is quite con-

[1] *The Economic Disposal of Towns' Refuse.* Published by P. S. King & Son Westminster, S W

sistent with the production of a considerable amount of power, it would be sheer folly to disregard a valuable asset

It is common in these days to find the commercial aspect too prominent, with the desire for sanitary improvement there is an overbearing anxiety on the part of the layman to know whether such improvements will pay—or commercially speaking—show a profit

If the councillor is assured that the only benefit accruing will be a lower death rate his sanitary zeal sometimes does not last long If a sweeping sanitary reform is calculated to add a few pence to the rates, the erstwhile rabid sanitarian decides that the Council rate must be kept down even if the death rate has to go up

It is indeed regrettable to think that this attitude may be largely attributed to the striking success achieved in some towns where Destructors have been employed in connexion with Sewage or Electricity Works, in the case of the former often saving the entire coal bill and in the latter case materially reducing the same

The layman too often fails to appreciate the difference between two towns, being possessed of the notion that what has been done in the case of (A) is equally possible in the case of (B), if it is not, then he at once exerts his influence against the introduction of a Destructor

It will be very evident that this is very mischievous, inasmuch as the Destructor does not appeal to a man of this type as a Destructor—a sanitary *sine qua non* but as a profitable undertaking commercially speaking and so we find that in some towns where it is not possible to combine a Destructor with an Electricity Works, Sewage Works, or Water Works, the introduction of the Destructor is resisted, or at any rate, left severely alone, until it cannot be neglected any longer

Notwithstanding the splendid progress already made in this country, much yet remains to be done It is, moreover, becoming increasingly evident that every shifty method of getting rid of filth will have to be abandoned, and that destruction by fire will, in course of time, become universal

PREFACE

Within these pages I have endeavoured to record what progress has been made the world over. At the same time special attention has been devoted to the modern developments in power production and utilization.

The usefulness of a work of this kind is much enhanced by the inclusion of data, tests, and actual working results. For much information of this kind readily furnished I tender my hearty thanks to many municipal engineers both at home and abroad.

Every care has been taken to include authentic or official figures only, but in the compilation of so many figures, it is possible that mistakes have crept in. Should any such inaccurate figures be detected I should be pleased to have the same brought under my notice for future correction.

In endeavouring to treat the subject comprehensively it has been necessary to discuss several matters which are highly controversial; in so doing it has been my aim to discuss principles rather than makes, and to avoid invidious comparison.

It is hoped at this time when the question of final and sanitary refuse disposal and power production is engaging the attention of so many authorities at home and abroad, that this work will be found of service.

W. FRANCIS GOODRICH

GLENLEA,
WATFORD.

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Again that portion which is so utilized is only turned to such account owing to the provision of the Destructor, that is, the power would not be required unless the Destructor had been installed

At the same time although such utilization of power does not effect any actual saving in the shape of a coal bill, yet it is eminently useful, because when a plant for the complete utilization of clinker is installed the power which would otherwise go to waste, by operating clinker screening and crushing plant, mortar mills and clinker brickmaking plant enables the clinker products to be sold at reasonable prices yielding a useful return to be set against capital and standing charges

In this way, as will be observed in the case of Bolton, a material reduction may be effected in the actual cost of destruction It will thus be seen that under given favourable circumstances the destructor which cannot be placed under the category of Power Destructors is yet often of remarkable economic value to a community

It would be unjust to makers of Destructors who have erected many such plants and misleading to the reader, were this not made perfectly clear Under favourable circumstances it is possible for such Destructors to be operated without any loss—that is, the sale of clinker and clinker products alone may suffice to meet all capital and standing charges

Much has already been accomplished in the way of clinker utilization, but a great deal yet remains to be done, and where circumstances warrant we shall undoubtedly see remarkable developments in the utilization of clinker What is being done in the various installations will be found recorded, and, in addition, a special chapter has been included in which some of the most recent and interesting developments are dealt with and illustrated At this stage therefore further reference to the matter would be superfluous

With the early type of Destructor of the low temperature, slow combustion type, boilers were but rarely installed and no attempt whatever was made to develop power The low temperature gases were useless for steam raising purposes, very frequently

not being sufficiently high in temperature to avoid nuisance

Tho residuum or clinker was soft and objectionable having no commercial value it being impossible to produce a good serviceable vitreous clinker unless a high temperature be reached and maintained in the cell

As the late Mr Alfred Fryer stated in a lecture at the Sanitary Institute in 1887 the public prejudice against the adoption of Destructors has been so strong that it was a marvel that the earliest destructors were ever erected

Even in these days very serious and determined opposition is met with at times in spite of the fact that the modern Destructor, carefully designed and properly operated is absolutely free from nuisance

With the early Destructors there was doubtless just cause for complaint tho design was weak and an even reasonably high temperature was never reached That noxious fumes did escape from the chimney is quite certain and there is every reason to suppose that at times quantities of very offensive dust also were discharged

Tho first serious attempt to prevent the escape of noxious fumes from the chimney was the fume cremator patented by Mr Charles Jones M I C E of Ealing in 1885 (Patent No 8 (90) The cremator may be briefly described as a secondary fire or fires arranged in the main flue in such a position that the whole volume of low temperature gases after leaving the cells must pass over the active cremator fire of coke or other fuel and under the concave side of a firebrick arch placed over the fire

That the Jones Cremator was useful is a matter of history the escaping gases were to a large extent deodorized but the cost of this secondary fire was in many cases found to be quite prohibitive materially adding to the cost of destruction

Mr Jones timely invention helped however to silence opposition to quote the inventor s own statement You must speak well of the bridge which carries safely over The cremator certainly had the effect of bridging over the period between low temperature and high temperature working

It will be evident that a secondary fire or cremator beyond

the cell could not possibly have any effect upon the actual operation within the cell, in this respect perhaps the weakness of the cremator was most manifest. Although the cost of destruction was higher, the residuum or clinker was still soft and worthless, and therefore so far the improved Destructor was a greater expense to the community than in its original state, the refuse being burned at a greater cost but still producing little or nothing of value as an asset.

Although there were some few installations with which multitubular boilers had been included at this time, the power produced owing to the low temperature system of working was but negligible. In one instance a drastic departure was made by setting a boiler immediately over a cell, the base of the boiler being practically in the fire; while this arrangement improved matters from the power producing standpoint it was doomed to failure because the primary purpose of the Destructor was effectually thwarted.

The gases as distilled from the refuse came into immediate contact with the large cooling surface of the boiler and anything like a reasonable temperature in the cell was thus rendered impossible; in short, efficient cremation was quite out of the question, and so the first attempt to produce a considerable quantity of steam had the effect of demonstrating in the most emphatic manner that complete combustion must be first secured, and that the primary function of the Destructor must always be to destroy, power production being a secondary consideration.

No real progress was made until it was clearly recognized that the old system of low temperature working was wrong, and that it must be superseded by artificial draught. With the introduction of forced combustion and high temperature working, complaints concerning nuisance ceased. The cremator having fulfilled its purpose was but rarely heard of and was no longer adopted.

Forced draught was clearly shown to be the real remedy, and a vital necessity for securing a sufficiently high combustion temperature to avoid nuisance. Instead of the slow low temperature distillation of the gases, or cooking of the material, the

fires were now vigorous and the temperature high the clinker previously soft offensive and worthless was now vitreous and serviceable and not only was nuisance prevented but the destroying capacity of a plant of given size was doubled a large and constant volume of hot gases passing through the boiler to the chimney

It soon became evident that a considerable volume of heat was being wasted, and an effort was made to provide and use steam other than that required for the forced draught at first this departure was confined to the operation of mortar mills screens hoists provender machinery and for similarly modest purposes

As the Destructor maker has been often charged with exaggeration it may be as well to observe at this point that directly the high temperature Destructor was producing a modest amount of steam enthusiasts began to predict a remarkable future for the Destructor these enthusiasts were not Destructor makers nor had they any interest in any particular type of Destructor

The harm done by enthusiastic professional men at this time has had its effect ever since Results in power production were prophesied which have not yet been attained and which never will be attained This is a candid admission but no apology is needed The modern Destructor has an excellent record but it has its limits and had this been recognized at its advent much misunderstanding might have been avoided and as the result greater progress might have been recorded

Although it must be frankly admitted that there is a very wide difference between the operation and steam requirements of a mortar mill and a high speed engine for electric light or traction purposes yet it must likewise be admitted that there is a great difference between the Destructor which was first found useful for the former purpose and its modern prototype as combined with the generating station This the author endeavoured to make clear in a paper read before the Institution of Electrical Engineers[1] (Manchester Section) in November 1902 from which

[1] See Proceedings (Manchester Section) Institution of Electrical

I cannot do better than quote in order to make the difference quite clear

When we have reached such a satisfactory position that it is possible to obtain from a boiler fired with Refuse Destructor gases an evaporative efficiency equal to that obtained from a similar boiler direct fired with the best coal then it may be fairly submitted that the Destructor is a valuable adjunct

It may be said that such a statement involves the doubt as to whether or not power production has become the primary function of the Destructor If any reader is possessed of such a doubt he may at once be assured that in the best modern practice the

Engineers 1902 *Electricity from Refuse—the Case for the Modern Destructor* By W Francis Goodrich

I venture to say that the best of modern destructors have only been designed by a process of improvement Of course there are members of your profession who still assert most positively that the available power is really only suitable for operating mortar mills and similarly modest machinery which require but little steam and at any reasonable or may be unreasonable pressure

If we are to take such statements as these seriously then we must perforce believe that we have made no progress during the past fifteen years because the destructor of fifteen years ago was quite equal to supplying steam for the work in question

Can it be seriously urged then that the destructor of to day is but on a par with its earlier prototype? Is it a fact that while every other branch of engineering has a record of remarkable progress this particular branch has stood still? It is not necessary for me to supply the answer those of you who have seen the earlier type of destructor know that immense strides have been made

Why was the old low temperature type of destructor of little use for power production and why was it the cause of endless annoyance and litigation? Broadly speaking for one and the same reason—worked at a low rate of combustion limited by natural draught low temperature gases only came into contact with the boiler fifteen years since it is safe to say *that the temperature of the gases entering the boiler never* exceeded 800° Fahr frequently falling as low as 600° Fahr Now in our best modern practice gases enter the boiler at a temperature of 2 000° Fahr or even higher and in a well managed plant the minimum tempe [illegible]

[illegible] to still tie the destructor to the despised mortar mill?

highest attainable temperature is reached *in the cell*, this being done the very conditions which are of the highest importance for perfect cremation are at once such conditions as must exist in order to obtain the very best results in power production

If you would ask—is the combustion perfect? it may be submitted that the attention paid to combustion in the case of the best modern Destructors is such as cannot be found with the majority of steam power plants where coal is used

The figures of analysis of the gases of combustion at several Destructor Works will be found tabulated herein and they are worthy of careful perusal and of critical comparison with the analysis of gases taken from the coal fired boilers working under ideal conditions

Such comparison will but clearly show that the combustion process in the case of the first class modern destructor is very much more efficient than with the average coal fired boilers and the modern Destructor chimney may be readily singled out in manufacturing towns as being the most free from offence and often the only clear chimney in the town

If a well designed modern high temperature Destructor is operated with reasonable care the chimney will always bear the closest scrutiny and generally speaking at the present time Destructor chimneys all over the country are absolutely void of offence It is true that occasional complaints are still made concerning one or two low temperature destructor chimneys but such exceptions only prove the general rule and when these old installations are converted to high temperature working complaints will cease entirely

Although very considerable alterations have been made in the design of destructor cells and although such alterations and improvements have all in the main contributed to the greatly increased efficiency yet by far the most important innovation was the introduction of forced draught and high temperature working Had every other improvement with the exception of forced draught been added to the original Fryer cell it is safe to say that but very little real progress would have been made

One has only to look at the matter from such a standpoint to fully realize what a drastic and far reaching improvement was effected by the addition of forced draught. Without it destructors would have become increasingly unpopular and by this time they would be classed among the failures of the past. Sanitation in so far as the final disposal of refuse is concerned would have received a rude check.

Strictly speaking many of the modern improvements have only become practicable because of the adoption of forced draught and high temperature working. Prior to the introduction of forced draught no real advance had been made, and all the many later improvements owe their inception either directly or indirectly to this first drastic improvement, the effects of which have been so far reaching and of such a character as could scarcely have been anticipated.

In spite of the remarkable improvement due so largely to the use of artificial draught a few strenuous advocates of the old system still remain. It is manifestly useless to attempt to convert such. If what has been accomplished all over the country during the past fifteen years does not carry conviction then it is too much to hope that any treatise on the subject can be of avail.

If the fact that no Destructor has been erected for many years past unless equipped with forced draught is not all sufficient evidence as to the value of the improvement, then but little more need be said. When actual demonstration has failed to carry conviction, argument is not likely to be effective.

It is safe to say that the Local Government would decline to pass any scheme for a Destructor unless artificial draught is provided, and herein lies the primary safeguard for the ratepayer, who may rest assured that every scheme submitted to the Local Government Board is carefully looked into in detail.

To the late Mr Alfred Fryer belongs the credit of first satisfactorily tackling the problem of final and sanitary disposal. It is true that during the twenty seven years which have passed since Mr Fryer erected his first Destructor great progress has been made by reason of improvements in design and construction, yet the fact remains that Mr Fryer solved a great difficulty,

and one which has been much aggravated by the rapid growth of our cities and towns within recent years.

The first two Destructor cells erected by the late Mr. Alfred Fryer at the Water Street depot of Manchester Corporation, in the year 1876, and shown in Fig. 1, are still in daily use. Within the past two years Meldrum's Forced Draught and grates have been applied to these two cells and also to ten other similar cells, greatly increasing the temperature and also the destroying capacity of the cells.

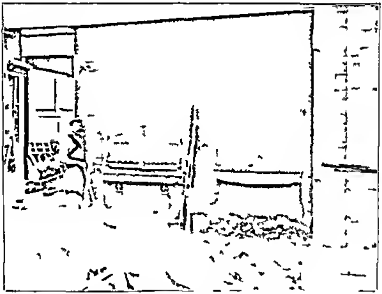


FIG. 1.—THE FIRST TWO DESTRUCTOR CELLS ERECTED AT WATER STREET DEPOT, MANCHESTER, IN 1876.

It is a striking tribute to the genius of the late Mr. Fryer that the essence of his original patent still forms the basis of nearly all the top fed Destructors offering. Mr. Fryer stated his principle as follows: "Charging or supplying the refuse to the cells at the back and drawing out the clinker—the residuum—at the front."

There have been many alterations and improvements in detail so far as the internal design is concerned, but the main principle as laid down by Mr. Fryer is still largely in evidence.

Although experience has shown many weak points in design

and construction the sanitarian will always honour the name of Fryer While the first destructor was not entirely satisfactory and would fall far short of modern requirements, its advent marked a new era in sanitation, and our present satisfactory position has only been reached by a process of evolution, which process was only rendered possible because of Mr Fryer's earlier efforts

In Mr Fryer's time the destructor had but few advocates, and critics innumerable The grateful thanks of every sanitarian are due to Mr Fryer, who had to contend with such determined opposition as would have daunted many men

Again Mr Fryer was offering a destructor far from perfect and nothing more He could not offer a good vitreous clinker even as an asset against the cost of operation He could not offer to provide power for electrical purposes sewage pumping, or water pumping in fact no return whatever could be offered and yet in spite of all, destruction by fire was firmly established in this country and is now recognized as the only satisfactory method of final and sanitary disposal

There are those who are ever ready to criticize and notwithstanding past experience, the destruction of refuse is looked upon by not a few as a very simple matter calling for no special engineering skill or experience We need not labour this point, it will suffice to say that the problems involved in combustion have been tackled in such a manner in this country as is without parallel elsewhere either in Europe or America, and our British practice in combustion even with any class of fuel is considerably in advance of what is being done anywhere outside of these islands

It is generally recognized by those competent to judge in America that our present satisfactory position has only been attained by scientific application and many American engineers have not been slow to fittingly recognize our premier position, at the same time deploring the apathy shown by their own countrymen, and the lack of attention given to those cardinal principles which govern efficient combustion

In order to show clearly how our British practice in refuse

disposal compares with American practice, I cannot do better than quote from the contributions of some American experts to a discussion[1] on "The Sanitary Disposal of Municipal Refuse" at meetings of the American Society of Civil Engineers held on December 17, 1902, and January 7 1903

Mr Rudolph Hering a recognized authority on the subject, said —

In Europe the Municipalities under the guidance of experienced engineer officers generally undertake the cremation by their own long trained employes while here with us the health boards or council committees select not only the design but indicate the method of operation appoint unexperienced employés or enter into a contract for immediate profit rather than for permanent efficiency

The difficulties underlying the problem of city refuse disposal which is almost wholly one of engineering have been solved satisfactorily where competent engineers have been employed for the purpose It is hardly to be expected that without professional skill and training desirable results can be reached in this any more than in any other branch of engineering

Mr H de B Parsons another expert said —

The failure in American cities has been largely due to faulty design of the furnaces and lack of high temperature (a most essential feature)

Colonel W F Morse the distinguished sanitarian said —

The comparison between English and American efficient disposal is distinctly against us

The work has been begun at the wrong end a sufficient amount of engineering skill was never applied to it Municipal Committees have gone about the country and have been persuaded by ambitious furnace builders to instal plants These plants have been simply experimental —built for a profit They were not durable and required extensive repairs In many cases they were not sanitary they emitted odours they were not in all respects adapted to the work required of them and they were expensive to operate

If progress is to be made it must be made either by inventing a new furnace or by adopting other furnaces which have been proved successful elsewhere

Mr Geo A Soper remarked as follows —

At the present moment the City (New York) is deplorably dirty

[1] See *Proceedings American Society of Civil Engineers* January 1903 Vol xxix No. 1

Business men and property owners are complaining that their refuse is not removed

The street cleaning department is struggling under the disadvantages of an incomplete and outgrown equipment It may seem like strong language but it is not beyond the facts to say that the system of cleaning the streets of the Metropolis if followed by a private Corporation would lead to bankruptcy

This latter quotation has only been included to show that even in the collection and removal of refuse as in its disposal, much yet remains to be done The authorities quoted are all recognized as experts in New York the reader must be impressed by the singular unanimity of opinion and the admitted unsatisfactory conditions obtaining

The whole position may be summed up by saying that current American practice is but on a level with our practice of fifteen years since and that our gradual but definite progress towards sanitary efficiency, and power production has been without any material effect in America

Certain it is that our position can only be approached by progress on the same lines as have been dictated by actual experience here, and such results as we now obtain can only be reached by practical and scientific application Until this is clearly recognized no real progress will be made This opinion is expressed not in any boastful spirit, but merely as the result of clearly appreciating the fact that the paramount difficulties presented in American practice are in the main practically the same as have been met with and sucessfully overcome in this country

Even as the design and construction of the destructor must always be recognized as the work of the experienced engineer, so should the choice of the type of the destructor most suitable for the *requirements* of a particular town be more largely left to the engineer or professional adviser It is a common practice for a deputation of town councellors to visit various towns and inspect different types of Destructors in operation While the worthy councillor leaves his business without a murmur, and gladly gives his time and services, he is not an engineer, he has no knowledge of the subject His experience is such that it is

manifestly impossible for him to critically compare different systems with any degree of fairness

A few minutes in a Destructor house with an anxiety to keep as far away from the dust as possible does not assist the councillor in coming to a fair conclusion nor under such conditions is it possible for the layman to acquire any really useful information Owing to the variety of destructors now offering, and their difference in design working conditions and results obtained in power production a hurried visit a few questions, and a superficial examination are of little service

To make critical comparison demands engineering knowledge and an acquaintance with Destructors generally Without such knowledge it is impossible to detect the weak points during an inspection The average town councillor is not technical, and yet he is constantly called upon to exercise a choice which demands technical knowledge If it were not for the controlling guidance of the permanent official—the municipal engineer—the ratepayer's money would often be very badly invested

Chapter II

REFUSE TIPPING ON LAND

EARLY in 1902, the Bury St Edmunds Corporation made application to the Local Government Board for sanction to borrow the sum of £300 for the purchase of a Refuse Tip

In due course Major C E Norton, R E, one of the Inspectors under the Local Government Board, conducted an inquiry into the subject of the application, and during the course of the inquiry he asked "*why the Corporation did not provide a Refuse Destructor?*"

After due consideration, the Local Government Board declined to sanction the loan application The Corporation, not anticipating a refusal, had concluded the purchase of the land, which amount has consequently to be provided out of the revenue

Although I cannot cite a similar case to this in any part of the country, it must be conceded that a very ominous precedent has been established, and we may confidently anticipate that the attitude of the Local Government Board towards the tipping of refuse will be less favourable in the future

The case of Bury St Edmunds furnishes a remarkable object lesson for hundreds of Municipal authorities in this country, who still accumulate filth At the same time the sanitarian must be encouraged by the ominous decision of the Local Government Board, accompanied as it was by the recommendation that a Destructor be provided

Mr G A D Mackay, the well known and able Cleaning Superintendent to Edinburgh Corporation, in his Presidential

address, delivered at the Edinburgh Congress of the Association of Cleansing Superintendents of Great Britain, in July, 1902, spoke as follows—

> Tipping in places of low depth, *and when isolated from dwelling houses and sources of water supply*, is not, *when carefully directed*, an insanitary method of refuse disposal *When, however, the depth is considerable, the benefit of aeration is absent, and no depositing* should take place, *unless the organic portion of the refuse is first removed by a process of incineration*

Mr Mackay is a distinguished sanitarian, and we may accept his advice as sound, but the more closely we examine his statements, the more firmly must we be convinced that he fails to present any logical argument in favour of tipping

FIG 2 REFUSE TIP AT [illegible]

Refuse Tips are too often *near* to dwelling houses, and being frequently provided by the scavenging contractor they are not carefully directed Again the depth is often very considerable; in the case of the huge tip illustrated in Fig 2 the maximum depth is nearly 60 ft

Mr Mackay expresses his opinion that the depth of deposit must not be considerable We know that in the case of hundreds of tips the depth is very considerable, in fact, the favourite site

for a tip is an old gravel pit, clay pit, or some hollow which has been excavated.

When sites of this character cannot be obtained the refuse rises from the level ground skywards, as is seen in Fig. 3, and so the tendency is all toward getting considerable depth, excepting of course when refuse is spread over land for manurial purpose.

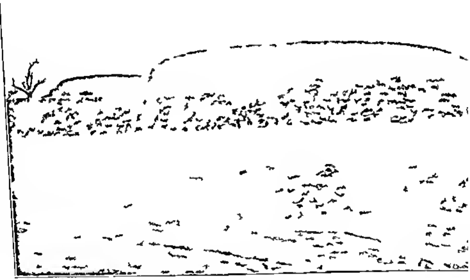


Fig. 3. 00 Tons of Refuse at Watfo

Concerning the use of refuse for manurial purposes it may be said that the farmer has had quite sufficient of the modern refuse all over the country; there is a growing disinclination to use refuse on the land largely because of its changed composition. The alarming percentage of tins and bottles in average refuse has caused the farmer to seek his manure elsewhere. This cannot but be very satisfactory to the sanitarian

and it further serves to emphasize the fact that the Destructor is the only solution

There is another aspect of the refuse tipping question which must not be lost sight of—the cartage cost Where tipping is as well directed as a filthy process can be, the tip is well outside of the town Many instances might be cited where refuse tips are situated from two to three miles out of the town Not only does this inflict a heavy cartage cost on the ratepayer as compared with cartage cost to a reasonably central destructor site, but the countryside is marred Many a lovely landscape is blighted by an unsightly, evil smelling dangerous heap of decomposing filth

Let us recognize clearly that not only does this shortsighted policy of accumulating filth entail the maximum cost of cartage to a community, but insult is added to injury by vitiating the atmosphere of the countryside by these vile deposits

On the whole very little indeed can be fairly urged in favour of tipping If Mr Mackay s remarks are carefully perused it will be seen that tipping can only be recommended under certain specific and ideal conditions such as do not obtain in or near the average town

But why in the name of common sense should the hoarding up of filth be reduced to a fine art? Why devote study to a system which generally speaking stands condemned from Dan to Beersheba a system which can never be final and which was recognized as an impossible one even before the Christian era?

Medical Officers of Health have long been aware that apart altogether from the disease spreading properties of the pestilential odours arising from refuse deposits there is much to be feared from the enormous numbers of flies

Every refuse tip has its plague of flies breeding and feasting in the filth and they multiply at an alarming rate Wherever organic refuse excreta or carcases either large or small, is deposited there flies may be found

That flies do not confine their operations to the refuse, is shown by the serious epidemic at Fratton only a year since At the coroner s inquest on one child out of three in one family

who had succumbed from an attack of virulent diarrhœa, the Medical Officer of Health and other expert witnesses emphatically asserted that the cause of the epidemic was the presence of insanitary refuse heaps in the locality from which the infection was carried to the house by flies which were in such numbers as to constitute a veritable plague

In his evidence, the Medical Officer said that on several occasions he had recommended the Corporation to provide a Destructor, but the suggestion had not been sympathetically received because of the expense The jury found that the cause of death was "*entero-colitis*" brought about by the contamination of food by bacteria, brought by flies from the refuse heaps

Here is a clear case of one community seriously suffering from the filthy deposits of another larger community—the important town of Portsmouth The Medical Officer of Health, Dr Mearns Fraser has repeatedly urged upon the Corporation the necessity for providing a Destructor Portsmouth with its two hundred tons of refuse daily is still without a Destructor but the Fratton epidemic had the effect of rousing the Corporation and it will not be long now before a Destructor is erected

Not only does organic refuse attract and aid the rapid multiplication of dipterous insects but every large refuse tip has its colony of rats in some instances running into thousands, houses in the vicinity are infested with the rodents and neighbouring crops are in some instances ruined by their depredations

In the town of Watford, owing to the presence of a large refuse tip in close proximity to the Workhouse and Infirmary, it has been found necessary in hot weather to provide "mosquito nets" to protect some of the infirmary inmates from the numbers of flies entering the open windows, and recently in the casual wards able bodied men have declined to work by day because the incoming rats have prevented their sleeping at night

It is indeed incongruous to find a large town provided with electric light and electric traction, but without any sanitary means of refuse disposal, for instance even at Portsmouth, where Dr Mearns Fraser tells us the Destructor question was not a

popular one, because of the expense, within the past few years about £250,000 has been spent on electric traction

In Dublin, where a similarly enormous sum has been expended on Lighting and Traction, the refuse disposal question is also generally unpopular because of the financial aspect In both cases, less than one-tenth of the sum found for electrical purposes would have sufficed to provide modern Destructors of sufficient capacity for many years to come

Many other similar cases might be cited such cases abound, serving to show that there is a strange reluctance upon the part

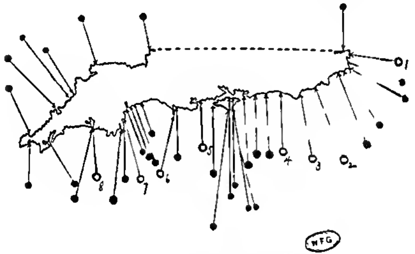


FIG 4 THE COAST LINE FROM WESTON SUPER MARE ON THE WEST TO MARGATE ON THE EAST
○ Seaside Resorts having Destructors
● Seaside Resorts without Destructors

of many important authorities to face a sanitary problem, although their first charge is undoubtedly the preservation of the health of the community

The conditions are precisely the same in a very large number of our boasted health resorts, both on the sea board and inland, while in many cases every modern improvement is adopted to enhance the natural attractions, the sanitary aspect does not receive attention and so it is that many of our so-called health resorts are insanitary in the extreme, and from a sanitary point

of view will not bear comparison with some manufacturing towns

At the present time, 100 well known and popular health resorts in this country are without means of final and sanitary disposal of their refuse, it may be assumed that in most cases the filth is accumulated in heaps such as are here illustrated Only a very few authorities send the refuse out to sea, and when this is done a considerable quantity is usually allowed to accumulate either at a depot or in a barge until a cargo is ready.

The time is coming when these unsatisfactory methods will have to cease, a health resort will yet be judged by its sanitary condition and only in so far as it conforms to a modern standard will it rank as a health resort A pure water supply, an efficient system of sewage treatment and disposal, and final and sanitary disposal of all civic waste by the agency of fire will yet be demanded as the essentials of a health resort

Out of a total number of 124 well known seaside and health resorts in England and Wales, twenty-four only have adopted Refuse Destructors A glance at Fig 4, showing the coast line from Weston super-Mare on the west, to Margate on the east, will show the slow progress in sanitation in well known seaside resorts Between these two points, eight seaside towns only have adopted Destructors, and in the case of one town at least the Destructor is altogether inadequate in destroying capacity and of old design

Fig 5 is reproduced from a photograph taken by the author It shows a large refuse tip estimated to contain 5,000 tons, and situated between Newport and Cowes, in the Isle of Wight, within a few yards of the main road which was frequently used by our late Queen when driving in the neighbourhood of Osborne House

Some large pigs will be observed in the foreground, while yet others are reposing in the filth, whereon apparently the pigs had been placed for feeding purposes Is it possible for the average man, even if devoid of sanitary knowledge, to look upon such a scene as this with satisfaction? Can such a practice be defended under any circumstances? One intimate with

methods of Refuse Disposal might perhaps expect to find such an example as this in some districts but hardly in the Isle of Wight—the Garden of England—and within three miles of a Royal residence ?

It may be as well to remark here that Refuse Tips are common in the Isle of Wight and many a lovely spot is marred by a heap of decomposing filth Not one of the popular seaside resorts on

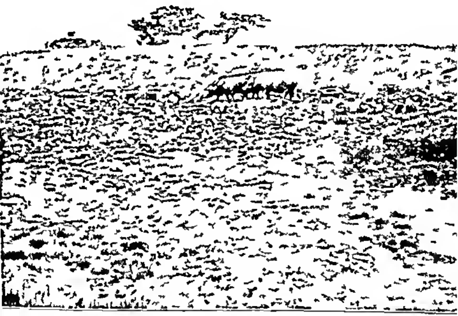


FIG PIGS FEEDING ON REFUSE AT NEWPORT ISLE OF WIGHT

the Island is provided with a Refuse Destructor and so far as the writer is aware no refuse is sent out to sea

Some of the technical sanitary journals notably the *Public Health Engineer* have again and again called attention in leaders and leaderettes to the glaring indifference shown in the case of many seaside and health resorts to the final and sanitary disposal of refuse Publicity of this kind has had the effect in

some cases of inducing the authorities to face the question but the figures here quoted indicate only too plainly that much yet remains to be done

At a meeting of the Worthing Town Council early in March 1903 Councillor Aston Chairman of the Sanitary Committee spoke as follows

> The [illegible] had arrived at the unanimous decision that it was the best thing to erect a Destructor. They spent a lot of time and money in beautifying the town and providing attractions for visitors *but the sanitary condition of the town was of even greater importance*

The above recommendation should not be passed over lightly for in it we have a most hopeful sign of the times. It is in effect a frank admission that the sanitary condition of a health resort is of greater importance than the provision of attractions

While this is only too obvious it is not often admitted as a rule money is spent freely in every direction in order to bring a health resort up to date with the exception of its sanitation which too often is crude and unsatisfactory in the extreme

That same enlightened policy and keen appreciation of the essentials of a health resort which we see shown in the case of Worthing might with advantage be emulated at some ninety nine other health resorts in this country as such is not the case however we can only be led to the conclusion that sanitation is not yet considered of vital importance

The disease spreading properties of organic refuse are too serious to be passed over lightly and when refuse is accumulated in close proximity to houses the consequences may be very disastrous Organic matter dug up after having been buried for many years has been found to be in an active state of putrefaction[1] It would seem that in many cases enormous heaps of refuse are allowed to accumulate in the hope that in some mysterious manner purification would take place automatically

Needless to add purification does not take place under average conditions and it is impossible to defend such a system it is

[1] See *The Economic Disposal of Towns' Refuse* W F Goodrich

filthy and unsatisfactory in the extreme. The advocates of the refuse tip are well aware that it is a menace to the public health but they fondly imagine that their every action will be finally judged from an economic standpoint.

After twenty seven years of disposal by fire and with such a large number of successful Destructor installations there is no reasonable excuse for the continued accumulation of organic waste. In a recently issued small volume[1] Dr G Vivian Poore clearly points out that organic refuse is the most deadly enemy of the soldier and it may be as truthfully said that accumulated organic refuse is a danger to a civil community.

Refuse tips have been sarcastically termed "Monuments of Municipal Wisdom" and when photographing the immense heap illustrated in Fig 3 and said to contain 20 000 tons of the filth of Watford it occurred to the writer that a huge notice board bearing the inscription "Video meliora proboque deteriora sequor"[2] would be a peculiarly fitting addition not only to this filthy heap but to many hundreds of similar composition large and small all over this country.

Such an inscription would suffice to explain why the filth had been so deposited and allowed to accumulate.

The Local Government Board much maligned as it is has done not a little in the encouragement of real sanitary progress. The reports of the Medical Officers to the Local Government Board concerning the sanitary condition of various towns furnish most instructive reading.

An outbreak of zymotic or preventible disease is generally quickly followed by searching investigation and every weak spot in sanitary administration is not only laid bare and criticized but a remedy is suggested. In perusing these reports the writer has been much impressed by the singular unanimity of opinion expressed by these qualified medical men as to the Disposal of Refuse. They do not recommend tipping on land or at sea whether the town be large or small the district urban or rural. A Destructor is recommended as a sanitary necessity.

[1] [illegible] By Dr G Vivian Poore

[2] [illegible] the worse

It should be remembered that the medical man advises as a sanitarian and not as a utilitarian, his standpoint is public health the power aspect of the question does not appeal to him, and it is manifestly absurd to attach the commercial stigma to his opinion The average citizen has but a faint conception of what he owes to the Medical Officer of Health and it is indeed curious that one whose labour is of such vital importance should so often be marked as unpopular

Even in America where a greater variety of methods of disposal have been tried than in this country it is becoming increasingly evident that in spite of all that has been attempted and even done disposal by fire is now recognized as the only real solution Whenever the subject is discussed the weakness and inefficiency of every system of disposal with the exception of cremation is freely admitted and not infrequently condemned In the proceedings of The American Public Health Association for 1902 will be found a contribution by Dr Heber Jones M D, President of the Board of Health of the City of Memphis Tenn The following extract from this contribution will serve to indicate the general trend of opinion among Medical Officers of Health in the United States —

> Unquestionably gentlemen and I do not care what the size of the city is whether it be New York with its four millions or Memphis with a little over one hundred thousand the proper plan for garbage disposal is to destroy it by fire and not to try to utilize it for feeding swine hauling it out and burying it or making any attempt at reduction There is plenty of food in the country to feed swine We do not want to pollute the atmosphere of the suburban portion of our city with the stench which emanates from hog pens and from the stuff which is hauled there a good part of which the hogs themselves will not eat Such in my opinion is a menace to the public health of any neighbourhood and is not only unsatisfactory but disgusting [1]

It is refreshing to find the President of the Board of Health for the city of Memphis Tenn thus not only advocating disposal by fire but also scathingly denouncing the feeding of swine with

[1] Dr Heber Jones M D before The American Public Health Association in Conference at New Orleans December 1902

garbage, a system of disposal which has been tolerated to some extent in the United States

As recently as two years since, a "Municipal Hoggery" was established in Worcester, Mass, the overseers of the poor collecting the garbage and feeding swine with the same at the City farm, an average of 1 800 swine being maintained by the garbage collected

The cost of garbage collection for the year 1900 was $17,000, and the receipts from the sale of pork $11 300 leaving a deficit of $5,700 Evidently the citizens and authorities are satisfied with the cheap method of disposal Maybe they congratulate themselves upon their success in this Municipal Trading effort There is certainly no sign that the sanitary aspect receives the slightest consideration, or that it is deemed of any importance

In the face of such evidence as is adduced in Fig 5, we cannot boast, but it may be truly said that in this country wherever garbage is used for feeding swine it is done secretly by a scavenging contractor While we have plenty of citizens and some few authorities with very hazy notions concerning sanitary science, yet in this country it is safe to say that a 'Municipal Hoggery" is quite impossible

The advocates of tipping refuse on to the land have again and again referred to its economic advantages In fact so much has been said concerning economy that one is almost persuaded that sanitary progress can only be permitted in so far as it is economical

The old analogy of 'the cart before the horse" is peculiarly fitting to such teaching as this Every level headed citizen, however, must know that the highest sanitation represents the highest economy and that economy without efficiency is generally speaking to be avoided

Mr W J Steele A M I C E, the Deputy City Engineer of Bristol recently presented some very interesting figures in a paper entitled Some Methods of Utilizing Town Refuse" Referring to the City of Bristol, he said —

During the year ending March 25 1903 85911 tons of refuse were collected or one ton for every four persons Of this quantity 33 14[illegible]

tons were treated at the Destructor, the remainder being tipped Had the whole of the refuse been treated at the Destructor, the total difference in cost over the cost of tipping would have been £3 500—equivalent to a halfpenny rate [1]

A simple calculation will show that to destroy 52,762 tons of refuse which is now deposited on tips, would add *one halfpenny to the rate* To thus change over from the present filthy and insanitary system of disposal at the expense of one additional halfpenny to the rate must appeal to the thoughtful citizen as economical It is a sweeping reform at a very low cost and such a case as this is typical of many while in not a few cases it would be cheaper to destroy refuse than to tip the same even if no power were provided

[1] Paper read before The Association of *Cleansing Superintendents* of Great Britain Bristol Conference June 1901

Chapter III

REFUSE TIPPING AT SEA

IF we examine into the methods of disposal in vogue at towns directly on the sea board or in such positions as would permit of the refuse being taken to sea it is both interesting and ominous to find that this method of riddance is not extensively employed

Although it is often cheaper to thus get rid of refuse than to destroy it there are many reasons which individually and collectively tend to pronounce the drowning of refuse as unsatisfactory in the extreme We will briefly review a few of these reasons

If we take the typical case of a town such as Dover we find a barge of considerable capacity moored conveniently in the harbour so that carts may tip their contents direct into the barge until sufficient refuse has been delivered to constitute a reasonable cargo Until then the barge remains in the harbour it is in fact a system of storage so far

Now it may be fairly submitted that storage of this kind is not satisfactory nor would it be tolerated in connection with a Destructor although in the latter case the material would be under cover while in the barge it is exposed

Again barges cannot proceed to sea in unfavourable weather and so the storage may be protracted It has in some cases been found impossible even when a barge is fully loaded to allow the same to proceed to sea for several days when the weather has been unpropitious

The alternative to storage in a barge is to provide a depot

as shown in Fig 6 but it will at once be apparent that this method is unsatisfactory The refuse is tipped in the open until sufficient has been accumulated to fill the barge it has then all to be shovelled into the tipping trucks which are then run out on to the wharf and tipped into the barge or hopper

With the intermediate handling of the material this system must be more expensive than tipping direct from the cart into the barge Again we have that open air storage which is most pernicious

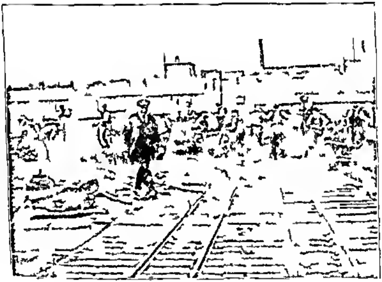


FIG 6 — REFUSE DEPOT AT BENWELL ON TYNE

The system illustrated in Fig 6 is in use at Benwell near Newcastle on Tyne and as will be observed the depot is in very close proximity to houses As is invariably the case the Medical Officer of Health condemns the method as insanitary and local medical men unitedly assert that it is a menace and danger to the health of the district It will thus be evident that even the preliminaries attendant upon dumping refuse at sea are most undesirable Storage either in the barge or at a depot is inseparable from the system because as a general rule some few

days' collection of refuse is necessary to make up a cargo for a barge or hopper.

Early in the present year at Benwell, owing to stress of weather, the refuse accumulated at the depot to the extent of 700 tons. Had this been an orthodox refuse tip, the material would have remained undisturbed, but being destined for dumping at sea, this unsavoury accumulation had to be broken up and handled.

Wherever refuse is thus stored at a depot for removal by vessel, regularity of removal cannot possibly be ensured; the system may work very well for three weeks or even three months if weather permits, but apart altogether from other considerations, can any system of disposal be deemed satisfactory which is only workable in favourable weather?

If the refuse is tipped direct into a barge or hopper, the same question arises; the vessel with its objectionable cargo can only leave its berth for the dumping area if the weather permits. Briefly, therefore, we may describe tipping at sea as a "fair weather system" as compared with the Refuse Destructor which is usually in operation for six days per week be the weather fair or foul.

In the case of a town where from 20 to 40 tons of refuse is collected daily, to send a barge out to sea every day or even alternate days would be prohibitive because of the cost. With large towns it is open to question whether it would pay to send the whole of the refuse to sea, because the collection area being wide it must necessarily be costly to bring the whole of the refuse to one point which is usually not central. But apart from the preliminary collection and storage, is it a final and sanitary system to send refuse out to sea?

Ten years ago Mr. John A. Brodie, M.I.C.E., the eminent City Engineer of Liverpool, expressed his opinion as follows:—

of watering places or may cause trouble to the fishermen These material however should be removed and dealt with by the Destructor, and if this was done there cannot be the slightest doubt that disposal at sea is at once the cheapest quickest and best system for the greater portion of the refuse *from those parts of Liverpool which lie within a moderate cartage distance from the docks*

Some years ago Mr Brodie brought that same intelligent application and inventive genius of his to bear upon the dumping of refuse at sea that he since devoted to the Refuse Destructor and it may be safely said that the sea dumping at Liverpool was conducted in a far more satisfactory and economical manner than has been the case in any other part of this country either before or since

In spite of this however Refuse Disposal in Liverpool has not developed along these lines on the other hand Liverpool has a number of excellent Destructors producing a very considerable amount of power for electrical purposes as may be seen by referring elsewhere in these pages

Mr *Brodie's statement puts the case very concisely* A sorting process is an essential part of sea dumping sorting is a degrading and filthy process and involves expense Further having removed such portions as should not go to sea what is to be done with that portion which is too objectionable to commit to the ocean? We are told that this portion should be burned in a Destructor Precisely—but if it is wise to destroy the objectionable percentage why drown that which is not harmful or likely to be productive of nuisance? why not burn the whole? Again it must not be forgotten that the portion which is not included in the category of objectionable matter is such as would be of great assistance in the cremation of the remainder

Around our sea board it has been conclusively proved that quantities of refuse dumped at sea are returned on the beaches of *adjacent seaside resorts* *Within the past two years* there has been a serious outcry on the north east coast where the beaches of seaside resorts have been defiled with the filth of large towns

Those who consider that refuse should be returned to the land for manurial purposes should derive some satisfaction from this, for they have as their allies natural forces and even after the

expense of thus sending refuse to sea it returns "back to the land"

It is well known that chemical change in organic matter is a very slow process in the presence of water, and decaying vegetable and animal substances deposited by the tide may be productive of very serious harm. While this filthy system continues, small seaside resorts although themselves provided with Destructors, will have to suffer from the deposits of larger towns in some instances a considerable distance away.

Thus to some extent does the dumping of refuse at sea involve the infliction of the filth of one community upon another, even as this is the case with thousands of tons of the filth of London sent into the country and there tipped.

Dr J B Cosby the Chief Health Commissioner for the City of New York told the author that it had been found by actual experiment that New York refuse must be taken 60 miles out to sea to ensure its non return on the incoming tide. At distances inside 60 miles constant offence was given by the deposit of all kinds of filth on the beaches of seaside resorts on the New Jersey coast, also at Coney Island and Far Rockaway.

To take refuse such a distance must obviously be expensive but the necessity for such transit was clearly shown in the case of New York by actual experience. When Mr G F Deacon M I C E initiated this method of disposal in Liverpool in 1879 the refuse was actually carried out to a point 24 miles from the landing stage.

Perhaps the weakness of this system of disposal is most conclusively shown by the fact that many towns having facilities for thus disposing of their refuse have after a trial adopted Destructors.

Again at the present time less than twenty per cent of the towns on or near the sea board send their refuse to sea, preferring rather to raise monuments on the land until such a time as they may decide upon the only method of final and sanitary disposal.

Chapter IV

SYSTEMS OF CHARGING REFUSE INTO CELLS

Direct Charging Systems

WITHIN the past four years, two systems of feeding refuse direct from the cart into the cell without intermediate handling have been devised Both systems are essentially different in detail, although possessing some advantages and disadvantages in common. It is proposed to consider the direct charging systems in question as distinct from systems of mechanical charging, which will be dealt with later.

It may be well to observe at the outset that there are objections inseparable from the principle of direct charging, either by mechanical means or otherwise, these are put clearly before the reader in the description of each apparatus It is for the purchaser to decide whether the sanitary advantages which accrue are such as will compensate for the manifest disadvantages

Stress is laid upon the sanitary advantages of such systems, and as the Destructor is primarily a sanitary adjunct, this aspect must be more or less prominent It would be idle to deny that a system which provides for the feeding of refuse into cells without serious intermediate handling is worthy of careful consideration

Direct charging would undoubtedly be very much more popular than is the case, if when once the material was placed in the cell no further attention was necessary, but this is not so, on the other hand, the saving of labour in actual charging into the cell has the effect of rendering the work of those beneath very much more arduous than is the case under ordinary conditions.

It is mainly for this reason that the material reduction in

labour cost which was anticipated, has yet been [illegible] there is now a tendency on the part of the [illegible] cates of direct charging to magnify the [illegible] which are more or less obvious, while the real [illegible] tages have yet to be demonstrated

It is scarcely necessary to insist that any system of charging should be as free as possible from mechanical [illegible] ances, and in any case the arrangements should be such that in the event of a breakdown an easy alternative system of [illegible] may be at once resorted to, as a stoppage without [illegible] of storage might have unpleasant results

Horsfall's Direct Charging System

As originally designed, a large pit was arranged in the [illegible] of a battery of cells placed back to back the top of the [illegible] hopper being level with the top of the cells its base being formed by an extended table above the drying hearth

It was anticipated that the bulk of refuse in the large [illegible] would effectually seal the opening and with this in view a sheet iron building was erected over the hopper the large [illegible] doors opening outwards to enable the cart to back against [illegible] tipping beam, and thus discharge its contents direct into [illegible] cell

The main trouble experienced was that the stored refuse [illegible] only failed to seal the opening but instead readily [illegible] expelling noxious gases

It was thus obvious that a means must be found of effect[illegible] covering the large opening into the cells in such a mann[illegible] would absolutely prevent the escape of gases After [illegible] various methods for keeping this door or lid tight the Ho[illegible] Company tried a water seal system which has proved to be [illegible] satisfactory.

Troughs are laid horizontally around the feed opening [illegible] connected with a feed tank which has a ball cock arrang[illegible] maintain the water at a constant level The lids covering openings into the cells, each weighing about one and a half

are suspended from winches, mounted on trucks which run on rails The winches are so arranged that by a few turns of the handle the covering lids can be raised about four inches, thus takes them clear of the trough and water seal and by means of the trucks they are then carried clear of the opening

The departure was a bold one, and of such a character as necessitated actual experiment under ordinary working conditions in order to arrive at the best methods of avoiding a serious escape of noxious gases

Having made clear that this system of direct charging is now quite satisfactory so far as the feeding in of the refuse is concerned let us examine more closely into the handling of the refuse below on the clinkering floor

A large quantity of refuse having been charged into the cell, the bottom of the mass rests on the table from which point it has to be dragged forward on to the grate proper as often as a fresh charge is required for destruction

As with other systems of direct charging so with the one we are now considering, the fact of the refuse being in the cell only tends to make more laborious the work of those who toil beneath on the clinkering floor Let me clearly explain why the work is more laborious—than for instance in the case of the ordinary top fed cell

In the latter case the refuse is nearer to the operator and it is more readily handled, being detached, and but a comparatively small quantity Whereas in the case of the direct charged cell the stoker has to manipulate a very long and heavy drag rake, and his difficulties are materially increased because of the greater distance the radiated heat, and the fact that by the impact of its own weight above and the effect of heat below, the mass of refuse is very solid and swollen

This difficulty may perhaps not appear at all serious to the lay observer, but it is nevertheless a difficulty, and, moreover, a very serious one

Mr J W Bradley, M I C E, the City Engineer of Westminster, in a report to the chairman and members of the Works, Sewers and Highways Committee, dated December 30, 1902,

remarks as follows concerning a test of Horsfall's Direct Charged Destructor at Shot Tower Wharf—

> With two exceptions the firemen worked well, but there is a tendency to avoid the use of the long pulling down rake and also to keep the fires too thin in front, which causes the fires in the front to burn in holes through which large volumes of cold air pass into the cell, tending to reduce the temperature, and as air under pressure naturally seeks the easiest outlet, this air does not pass through the refuse on the other portions of the grate.

Mr Bradley expresses himself very clearly and concisely, and on the whole his opinion serves to emphasize what has already been said concerning the long rake and the very arduous labour involved in properly using the same.

It should be borne in mind that to drag the material away from a compact mass and spread it evenly over a large grate area is very heavy work, and as this operation must necessarily take place with an open door, the stoker is exposed to intense heat, it is therefore not surprising to find that there is a tendency on the part of the man to shirk this work, as Mr Bradley points out. If the dragging and spreading operation is not thoroughly carried out, generally efficiency is impossible.

In endeavouring to make this aspect quite clear, there is no intention to unfairly criticize the particular system of charging which we are now considering, but rather a desire to place clearly before the student of the subject and the sanitarian the incontrovertible fact that however expeditiously refuse may be put out of sight by direct charging into the cells, very arduous labour is in store for those below.

The superficial observer is apt to content himself with watching the charging process only *from above*, and, as compared with other systems which he has seen, he is at once favourably impressed with direct charging, as seen from *above*. It is not only sanitary and expeditious, but it also appears to be economical.

The late Mr John McTaggart of Bradford, whose name will always be remembered in connection with many useful innovations in Destructor practice, was of opinion that this system of direct charging would be the means of reducing the labour cost to 5½*d*

per ton of refuse destroyed Unfortunately, Mr McTaggart did not live long enough to realize the difficulties which were presented, and which to a large extent have now been successfully overcome it is also open to serious doubt whether Mr McTaggart foresaw what labour would be involved below in the use of the long drag rake

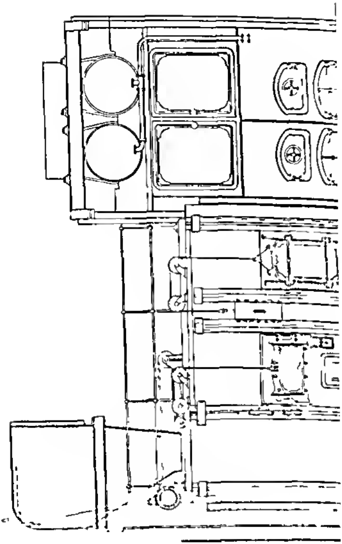
At the present time, one is obliged to judge the system in question from the performance of one working example only, that at Shot Tower Wharf, now under the control of the City of Westminster, and adverting again to Mr J W Bradley's report, the cost of labour per ton of refuse destroyed is given as 11 5*d*, exclusive of engineman and fireman (16 5*d*)

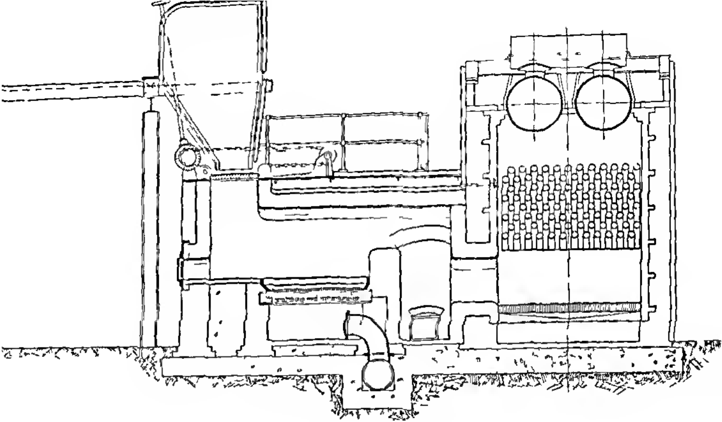
As the complete figures of the test referred to will be found on another page, it is unnecessary to further deal with the same here It will suffice to say that the labour cost is high, and this must to a large extent be accounted for by the work below, as the rate of combustion was not abnormal, being only 27 2 pounds per square foot of grate surface per hour

It is, however, but fair to state that a quantity of market refuse has to be dealt with, and a proportion of this material would doubtless be of a bulky nature, as compared with average ashpit refuse

With this system of direct charging, although refuse is actually stored in the cell, the storage capacity is strictly limited It may be assumed that further storage capacity in the cell is not practicable, to provide the same would involve greater width between the clinkering floors of the cells, and consequently the dragging forward and levelling of the refuse would become increasingly difficult, as this would necessitate the use of a still longer drag-rake.

Owing to the irregular delivery of the refuse and to ensure actual charging from cart to cell, the only solution is found in the provision of a number of extra carts in which the refuse is stored until required.





9 MELDRUM'S, BEAMAN & DEAS TYPE OF DESTRUCTOR WITH MARTIN'S PATENT DIRECT CHARGING APPARATUS
Section through Cell and Boiler

SYSTEMS OF CHARGING REFUSE INTO CELLS

Marten's Patent Charging Apparatus

The first charging apparatus devised is shown in Figs 7 and 8 It is known as Marten's Patent and is exclusively used in connection with Meldrum's Simplex and Beaman & Deas' type of Destructor

Briefly described the apparatus consists of a wrought iron hopper, placed on the top of the cell and immediately over the drying hearth On the right hand side of each hopper a hand wheel and lever is placed which operates simple toothed wheel gearing beneath

It should be pointed out that the tipping platform must be practically the same height above the clinkering floor level as with the Horsfall Direct Charged Destructor and Boulnois & Brodie's Mechanical Charging system viz —about 18 feet

A cart arriving upon the tipping platform is backed against the tipping beam The wheels travelling in guide lines ensure each cart tipping its contents clean through the hopper Immediately upon the signal being given from below that the cell is ready for a charge the man on the tipping floor turns the hand wheel previously *referred to* and *the hopper* base 5 ft *long by* 2 ft wide slides clear of the opening The load of refuse is then at once tipped direct through the hopper into the cell beneath

The cell is so arranged that the mass can be readily manipulated and levelled it being possible both to get behind and at the side of the cell Behind where the bulk of the work is done the stokers are within 3 ft of the refuse and *push* it forward this work being done under cool conditions whereas with other systems of back and direct charging all manipulation is done at the opposite side of the cell the stoker having to drag from a distance while exposed to the glare and heat radiating from the cell The rapidity of charging is very remarkable and no doubt to some extent the very expeditious tipping van employed contributes to this

At the Tooting Destructor under the Metropolitan Borough of Wandsworth where this system of direct charging is in use, not only is the charging got through very smartly but the labour

cost is phenomenally low being 7¾*d* only per ton of refuse destroyed The figures of a continuous test of 120 hours duration with this plant will be found on another page and are worth careful perusal

With regard to the question of storage the system demands probably twice as many collection carts as under ordinary conditions the refuse being stored in the carts While this is a very satisfactory method of storage it involves an extra capital expenditure in vehicles which many authorities will not entertain Cart storage is however not entirely confined to this system of charging being also the method employed with Horsfall s System of Direct Charging as already pointed out

In the event of any accident to a hopper which however is very unlikely owing to the extreme simplicity of construction it is possible to at once resort to ordinary top feeding the carts discharging over the tipping beam on either side of the hopper for the time being

The sliding hopper base covering the charging hole is perfectly gas tight and there is no escape of gases even while the base is removed during the charging operation

The low labour cost with this system is largely due to the fact that the men below work at the cool end of the cell *pushing* the material at close quarters instead of dragging it from a considerable distance

The actual labour involved below although performed under cool conditions is nevertheless arduous That the system is economical in labour cost is clearly shown by the very low cost per ton of refuse destroyed viz 7¾*d* and this in spite of the fact that in ordinary working the average rate of combustion exceeds 60 lbs per square foot of grate surface per hour or over 16 tons per cell per 24 hours

Back Hand or Shovel Fed Cells

Perhaps the best known example of the back shovel fed type of Destructor cell is the Horsfall and it is both interesting and

Marten's Patent Charging Apparatus

The first charging apparatus devised is shown in Figs 7 and 8 It is known as Marten's Patent and is exclusively used in connection with Meldrum's Simplex and Beaman & Deas' type of Destructor

Briefly described the apparatus consists of a wrought iron hopper, placed on the top of the cell and immediately over the drying hearth On the right hand side of each hopper a hand wheel and lever is placed which operates simple toothed wheel gearing beneath

It should be pointed out that the tipping platform must be practically the same height above the clinkering floor level as with the Horsfall Direct Charged Destructor and Boulnois & Brodie's Mechanical Charging system viz—about 18 feet

A cart arriving upon the tipping platform is backed against the tipping beam The wheels travelling in guide lines ensure each cart tipping its contents clean through the hopper Immediately upon the signal being given from below that the cell is ready for a charge the man on the tipping floor turns the hand wheel previously referred to and the hopper base 5 ft long by 2 ft wide slides clear of the opening The load of refuse is then at once tipped direct through the hopper into the cell beneath

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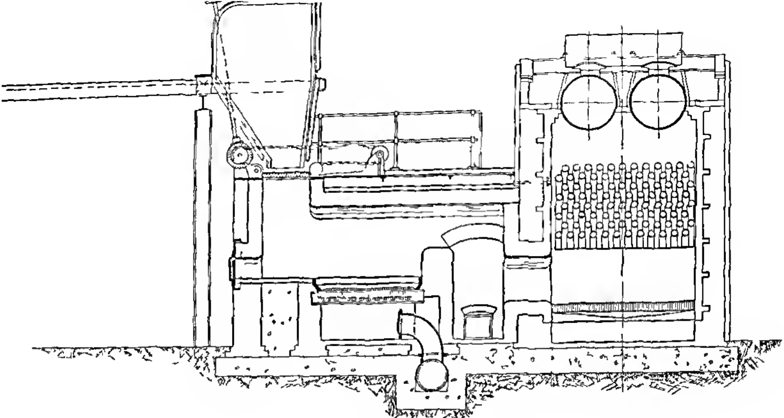


8 Meldrum's Beaman & Deas Type of Destructor with Marten's Patent Direct Charging Apparatus
Section through Cell and Boiler

instructive to compare actual working results obtained with this system and those obtained with cells of the top fed type

It is conceded by the makers that with the back fed type the fires are under more direct control and it may be assumed that this is quite correct Further the system of back shovel feeding has undoubtedly found considerable favour and largely because it approaches a rational system of firing By this of course hand-firing is meant

The very satisfactory results obtained with back feeding clearly demonstrate the advantages over top feeding Again the makers invariably recommend the back fed type in cases where it is proposed to fully utilize the power for steam raising purposes

With this type the refuse is shot on to the charging platform, or feeding bin the level of which is usually arranged about eighteen inches below the sill of the feeding doors As compared with the top fed type it will thus be seen that the refuse is stored in a comparatively cool place—a distinct advantage

All the material is fed into the back feeding doors and deposited direct on to the drying hearth by shovel the actual labour involved in shovelling is not serious the lift being but eighteen inches as already pointed out

From the drying hearth the refuse is dragged forward on to the grate proper the dragging spreading and levelling operations taking place from the clinkering floor level beneath and immediately opposite

The manipulation of the material must be comparatively easy, and far less laborious than is the case with the direct charged cell because the stoker is now dealing with a comparatively small quantity of refuse detached and within easier reach It will be evident that there are advantages in connection with this system of feeding as compared with top feeding which cannot fail to impress the close observer and it may be safely said that this system of feeding will become increasingly popular

Although the makers of the Horsfall back fed type of cell do not claim that any economy in labour is possible with this system as compared with their top fed type yet a perusal of the latest available figures will serve to show that with the back fed

type some very low labour costs are recorded The general arrangement is shown in Fig 9

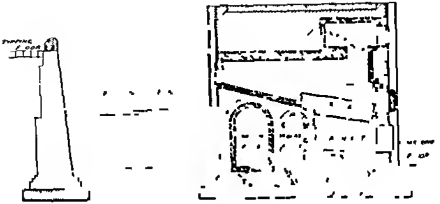


FIG 9 HORSFALL'S DESTRUCTOR BACK SHOVEL OR HAND FED TYPE

Meldrum's Back Shovel Fed Type

This type does not call for any lengthy description being practically the same as the Horsfall type the gases however instead of leaving the top of the cell at the front have a sideway motion over the continuous grate into the combustion chamber Figs 10 and 11 illustrate the general arrangement

The *Heenan* back fed type of Destructor differs essentially from that designed by Messrs Horsfall and Meldrum instead of feeding the refuse direct on to the drying hearth by shovel a hopper is provided at the back of the cell into which the refuse is tipped direct from the cart

It would be idle to closely compare the two systems because of the material difference in design and method of charging With the Horsfall and Meldrum back fed cell the charging of the material is readily managed as has been described the man responsible for charging having direct and convenient access to the drying hearth and cell

With the Heenan type however the main work of charging must necessarily take place from the clinkering floor the refuse

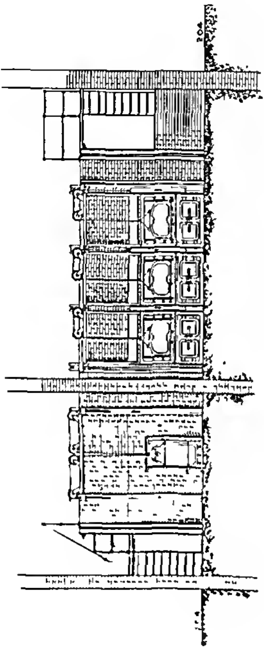


Fig 10 Meldrum's Patent Simplex Regenerative Refuse Destructor Furnace, Back Feed Type
Front Elevation

being dragged from the hopper base by means of a long drag or rake If the hopper provided has any appreciable storage

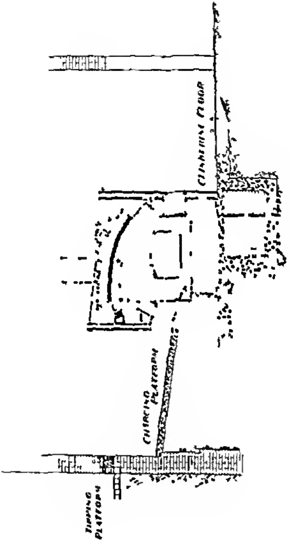


Fig 11 Meldrum's Patent Simplex Regenerative Refuse Destructor
Furnace Back Feed Type
[illegible]

capacity the drag must be so much longer and the work involved so much the more exhausting The back charging hopper is shown in Fig 12

Appreciating the difficulties and labour thus involved in charging, the makers of the Heenan Destructor have introduced a ram which is placed outside of the hopper to push the refuse

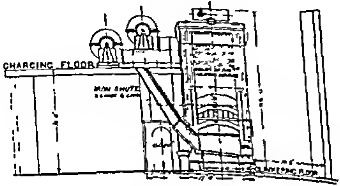


FIG 12 HEENAN'S DESTRUCTOR BACK HOPPER FED TYPE. Section

forward, but as this is a system of mechanical charging, it will be found described among the other mechanical charging apparatus

TOP FEEDING

In the top feed type of cell we have practically in so far as the feeding is concerned the essence of the original "Fryer" patent [illegible]

ing [illegible]

out [illegible]

It will be observed that the word back is used but a glance at Figs 9 and 14 will serve to make clear that while top and back feeding are both alike correct the former word more correctly expresses now where the material was actually introduced

In Mr Fryer's time, there was no back fed Destructor as we understand the term now, and it is perhaps necessary to emphasize that the original Fryer Destructor was fed on *top* as there is a distinct and very material difference between the two systems of feeding

Mr George Watson thus clearly defines top feeding—

With top feeding the refuse is merely pushed blindly in.[1]

In a very few words, the operation of top feeding is thus tersely described, and in most systems refuse thus pushed into a charging hole can only be manipulated from one point, i e, the clinkering floor Where the cells are arranged back to back this is the case, and as it does not admit of any modification, a serious disadvantage thus exists, for which, owing to the method of construction there is no possible remedy

This trouble is also met with in older installations of single

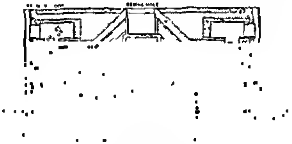


FIG 13 HORSFALL'S DESTRUCTOR TOP FED TYPE
Section through Cells

row cells, fed at the top, Access is not provided to the back of the cell, excepting of course through the charging hole, and but little can be done in the way of useful manipulation from that point for obvious reasons

In order to clearly understand this, it is necessary to compare Figs 13 and 15 How the difficulty has been got over with Meldrum's Improved Top Fed type of Destructor, as arranged in single row, may be seen by referring to Fig 15 If, however, this particular type of Destructor was arranged back to back the same difficulty must necessarily exist

Probably the most valuable modification of the top fed type

[1] *Watson on Refuse Furnaces. Proceedings of The Institute of Civil Engineers*, vol cxxxv. Session 1898-99, Part 1.

of cell was the front exhaust introduced by Messrs Horsfall to ensure that the volume of green gases, as distilled from the material on the drying hearth can only leave the furnace by passing over the grate proper, and commingling with the hot gases passing therefrom in the same direction Fig 13 illustrates the Horsfall Top Fed Type of Destructor as arranged back to back

The arrangement of the original Fryer cell was such that the entire volume of gases left the cell at the back, passing over a

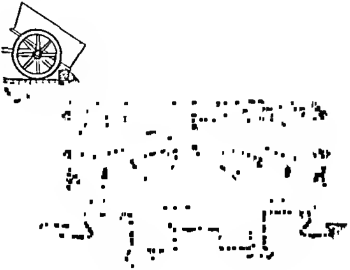


Fig 14 Fryer's Original Top Fed Destructor

bridge, and thence downwards direct into the main flue See Fig 14.

This method of exhaust was unquestionably weak, the noxious gases and dust having direct and immediate access to the main flue, and the fact that the early installations were of the low temperature slow combustion type added materially to the possibility of nuisance

One of the great objections to the top fed type of cell, both in its original and modern form, is the presence of large quantities of refuse on the more or less heated top of the cells. Not only

is it highly objectionable to thus warm refuse exposed to the atmosphere but the effect of the constant contact with heated surfaces is to reduce some of the naturally dry material to fine dust When the mass is disturbed at the time of charging this offensive dust which may be of a dangerous character is liberated

Even if every door and window in the building is closed with a fœtid dust charged atmosphere the conditions under which the men have to work are very offensive It so happens however, that in the average Destructor building some doors or outlets are constantly open and not a few of the complaints concerning annoyance from Destructors may be attributed to the escape of dust and fumes from the building

It is safe to say that the top fed type of Destructor is the most grievous offender in this respect and largely because the refuse is not kept cool

There is undoubtedly a strongly growing feeling on the part of Municipal Engineers in favour of cool storage If proof of this be needed then it may be found in the fact that the majority of Destructors erected during the past few years have been of the hand or front feed and back shovel types an outstanding feature of both being cool storage

It is scarcely necessary perhaps to point out that an inclined roadway is a general necessity for the top fed type of Destructor, unless a naturally favourable site be available abnormal excavation be decided upon or elevators be provided The inclined roadway is costly to construct occupies considerable space and under the most favourable circumstances cannot be made to look very picturesque Naturally favourable sites are the exception Abnormal excavation is costly and often prohibitive even if not impossible while elevators whether operated by hydraulic power steam or electricity must be duplicated in view of the always possible breakdown and consequent stoppage Again elevators or hoists have to work under naturally unfavourable conditions and as a general rule they are roughly handled

Figs 15 and 16 represent Meldrum s Improved Top Feed Destructor as arranged in single row The two outstanding features of this make as compared with other top fed cells in single row,

may be briefly summarized as follows —Instead of dumping the refuse on top of the cell in contact with a hot surface, it is tipped on an inclined steel storage hopper, being dragged forward and fed

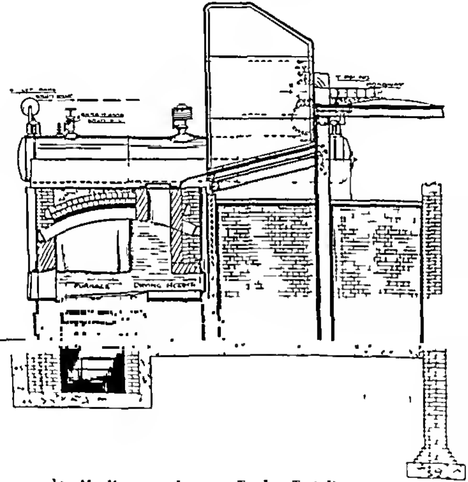


Fig. 15. Meldrum's Improved Top Fed Type Destructor.
Section through Cells.

into the charging holes as required The advantage of this will be at once apparent cool storage accommodation is secured, yet within easy access of the charging or feeding holes

Further, as doors are provided both at the front and at the

back of the cell—under the storage shoot, the clinkering process

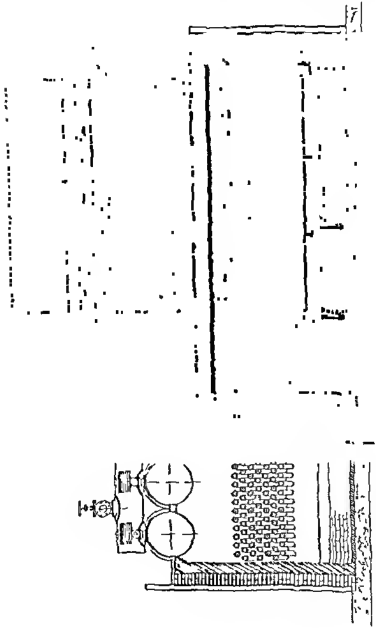


Fig. 16.—Meldrum's Improved Top Feed Type Destructor.
Front Elevation

is much facilitated. Again, when a fresh charge of refuse is

required on the grate proper the material can be manipulated from the two opposite points It is thus possible to charge spread and level a fire very quickly, and with comparative ease because the usual pulling or dragging operations are supplemented by pushing from the opposite side of the cell

It must not be forgotten that with the top fed cell objectionable refuse can be charged more readily than is the case for instance, with shovel feed at the front or the back Where a proportion of excretal matter has to be destroyed it would be manifestly objectionable to handle this by means of a shovel By feeding such material in at the top of the cell, external handling is to a large extent avoided, as it admittedly should be, but with the average ashpit refuse there is no reason, sentimental or otherwise, why the shovel feed should not be employed

We now come to the economic aspect of top feeding It is however, unnecessary to make close comparison here because this may be readily done by referring to the tabular statements included It may be said that on the whole top feeding has no economic advantages over front or back shovel feed The average labour cost per ton of refuse destroyed is certainly not less and in quite a number of instances it will be seen that shovel feed is rather cheaper

Front, Hand or Shovel Feeding

The feeding of refuse direct from the storage hopper into the cell by shovel may be said to represent charging in its simplest and most direct form It is necessary at the outset to clearly differentiate between front and back feeding by shovel, although manual labour and the same tool is employed with both systems, yet there is a very material difference

With back shovel fed cells, the refuse is stored loose on a charging platform, placed parallel with the cells, the sills of the back charging doors being about eighteen inches above the platform level In the case of front feeding the refuse is contained in an enclosed storage hopper, placed parallel with the cells, the

base of the hopper being eighteen inches above the floor level, and two feet beneath the furnace or cell doors

It will thus be seen that in both cases the actual labour involved in shovelling is about equal, but whereas in the former case the refuse is fed on to a drying hearth, from which point it has to be dragged, spread and levelled later, this work being done from the clinkering floor level opposite with front feeding by shovel, the *one operation* suffices to place the refuse where it is wanted immediately In short the feeding operation is such that a level fire is obtained forthwith and dragging, spreading and levelling as an additional and later operation is entirely avoided

Labour is thus concentrated at the *front* of the cell, there being no additional work involved at any other point It is necessary that this should be borne carefully in mind, as it goes a long way towards explaining why the labour cost per ton of refuse destroyed is low, notwithstanding the fact that every pound of refuse is handled by shovel

The fact that the whole of the work of feeding consists of *one operation* only, is the explanation, and it will be clear that apart from the obvious economic aspect, extreme simplicity is a prominent feature

To the lay observer, shovel firing does undoubtedly appear to be costly, but the close student of the subject is well aware that *front and back shovel fed systems can successfully compete* with any other system yet devised for low labour cost

Perhaps front shovel feeding has had its most strenuous advocate in this country in the person of Mr F W Brookman, the Cleansing Superintendent of Rochdale For nine years past Mr Brookman has destroyed the refuse of Rochdale at a labour cost of 7½*d*. per ton only, a figure difficult to improve upon under any conditions.

It is now clearly recognized by those competent to judge that the system we are considering is economic in labour cost. Three years since Mr Brierley Denham Healey, in a paper read at the Royal United Service Institution, expressed his opinion as follows—

It is a proceeding which is not more laborious than top feeding if proper arrangements are made for storing the refuse as regards suitability of level and distance from the firing doors[1]

Front feeding by shovel is always associated with the name of Meldrum these makers introducing the system and it is still their speciality It is unnecessary here to describe the type of cell which is used for this system and which largely contributes to the success of the same as this is dealt with fully in another chapter

Some opponents of front shovel feeding have stated that one serious objection to the system is the fact that the clinker is withdrawn from the same door as the refuse is fed in Those who seriously put this forward as an objection must not forget that this is done with every steam boiler hand fired with coal but a fireman worthy of the name would not clinker a fire five minutes after introducing a charge of coal on the other hand he would burn his fire down So with the Destructor in question the fire is so burned down previous to the clinkering process that vitreous clinker alone remains If any doubt still exists the reader may be satisfied by carefully looking into the analyses of clinker in various towns these are but typical of others and a guarantee as to complete freedom from organic matter and combustible may be readily obtained

The feeding of refuse by shovel and in small quantities into a hot and active cell means rapid distillation and also rapid ignition the gases being naturally small in volume the temperature as a whole does not materially suffer

The fact that with this system the cell is *always active* should be carefully borne in mind—refuse is being fed into a cell which is in work Now with every other system of feeding the cell is idle from the time clinkering commences until the fresh charge is ready for treatment That the cell which is ever active has advantages over all others cannot be disputed

It has been often said that the secret of burning coal properly

[1] *The Economical Disposal of Town Refuse* By Brierley Denham [illegible] *Proceedings of The Society of Engineers* 1900

is to fire a little at a time and often' Where this advice is carefully acted upon the smoke trouble is unknown and a remarkable fuel efficiency is obtained

No one would be so foolish as to dump one ton of coal into a furnace—the result would be disastrous even if the coal was comparatively free from moisture on the other hand it is well known that in the destructive distillation of coal it is best from every point of view to introduce the fuel regularly and in small quantities The best practice in hand and machine firing clearly shows this

In spite of this there are those who would introduce large quantities of refuse heavily charged with moisture into cells which are in a comparatively cool condition As a system which *is diametrically opposed to the best practice in the combustion of* coal and that system of feeding refuse which we are now considering it must be judged by critical comparison of the results obtained

Lastly it is claimed for back shovel feeding and rightly too that the man has direct control over the fire but it must be conceded that this is also the case to a greater extent with front shovel feeding because the draught and thickness of the fire are under the immediate control of the man who is feeding the cell If for instance a hole or thinly covered place is detected on the grate a shovelful of refuse can be immediately supplied

On the whole shovel or hand feeding has many conspicuous advantages that it is becoming increasingly popular is only what might be reasonably expected The remarkable strides made during the past few years however must have surprised even the most ardent advocates of the shovel

MECHANICAL CHARGING (*Heenan's System*)

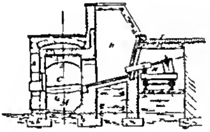
The Heenan back fed type of Destructor originally charged in the same manner as Horsfall's Direct Charged Cell has been recently modified with a view to materially reducing the labour involved in dragging the material from the hopper base and spreading the same over the grate

As will be seen by referring to Figs 17 and 18 a ram is placed external to the hopper base, pushing the refuse forward on to the

Reference A Ashpit C Cell D Deflecting Arch G Grate F Refuse Arrows indicate direction of gases

FIG 17 HEENAN'S RAM FED DESTRUCTOR
Elevation

grate The working parts of the ram are exterior to the hopper, the weight and guiding of the ram being taken on rollers The ram is driven by a worm wheel and screw and is put into operation by setting a friction clutch in gear The stroke of the ram is however necessarily limited and refuse is such an unknown



Reference A Ashpit B, E air duct C Cell D Deflecting Arch G Grate H Hopper T Tipping platform K Mechanical

FIG 18 HEENAN'S RAM FED DESTRUCTOR
Section

and extraordinary quantity that it is too much to hope that the drag or rake can be entirely dispensed with

Again the grate must be fairly evenly covered and this must demand attention at the front with firing tools so that on the

whole the sweeping reduction in labour cost anticipated can hardly be realized

The ram system of charging does not appear to be novel, a patent No 2 052 of January 26 1898 was granted to Mr T W Baker but apparently it has not been put into actual use before

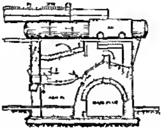


FIG 19 FRYER'S IMPROVED TOP FED DESTRUCTOR EMBODYING BOULNOIS, WOOD & BRODIE'S PATENTS
Section through Cell

BOULNOIS AND BRODIE'S PATENT CHARGING TRUCKS

The first system of mechanical charging introduced, and perhaps the best known is Boulnois and Brodie's Patent the sole licensees being Messrs Manlove, Alliott & Co

The general arrangement will be clearly followed by referring to Figs 19 and 20 and may be briefly described as follows —

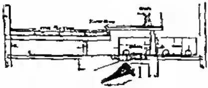


FIG 20 BOULNOIS & BRODIE'S PATENT CHARGING TRUCK

Wrought iron trucks are provided, usually 5 feet wide and 3 feet deep, the length being determined by the amount of storage required Each truck is divided into several compartments, each of which will contain sufficient refuse for one charge The

Chapter V

BRITISH DESTRUCTORS DESCRIBED AND ILLUSTRATED

Fryer's "Improved" Destructor embodying Messrs Boulnois Wood & Brodie's Patents

THE modern "Fryer" Destructor as made by the makers of the original "Fryer" Destructor, possesses several novel features in design and construction and materially differs from other modern Destructors with the single exception of the "Warner" Destructor

The leading features of the Destructor which we are now considering may be summarized as follows —

(*a*) The setting of a Babcock and Wilcox boiler between two cells this arrangement being known as Wood and Brodie's patent system of boiler setting

(*b*) The charging of the refuse into the top of the cell without intermediate handling by means of charging trucks which travel on rails on the top of the cell These charging trucks are divided up into compartments each of which contains sufficient refuse for one charge Each compartment is provided with a hinged base which is automatically opened when the truck is brought into the required position over the charging inlet on top of the cell The charging apparatus employed is that known as Messrs Boulnois and Brodie's patent The grate area of each cell is 2[illegible] square feet and at the back of the grate a drying hearth is arranged having an area of about 20 square feet

After clinkering the refuse contained on the drying hearth is pulled forward on to the grate proper it is then spread and levelled over the grate The gases leave the cell at the side through an opening in the side wall of the cell next to the boiler

and at once impinge upon the boiler tubes, the side wall of the cell forming the boiler setting

The boiler receiving the gases on both sides from the Destructor is accessible in front for coal firing in the usual manner if necessary, or a coke fire may be provided at this point as a cremator if so desired

The advantages claimed for the method of boiler setting employed are briefly as follows —

(1) The gases are raised to a high temperature in the firebrick cell, and are passed directly into contact with the heating surface of the boiler, thus saving loss of heat and wear of flues

(2) The gases after passing through the boiler are much reduced in temperature and therefore in volume and velocity and more readily deposit the fine dust in the large main flue from which it is easily removed

(3) The fire grate of the boiler can be used as a cremator during the drying of the green cells and afterwards as an auxiliary steam raiser if at any time required

(4) The boiler can be used as a steam generator, entirely separate from the Destructor gases in the event of any insufficiency of refuse, or if the cells are idle for repairs

(5) The Destructor cells have an alternative connection direct to the flues and therefore can be used as ordinary Fryer cells in the event of the boiler being idle for cleaning and repairs

(6) The additional space required for the boiler is reduced to a minimum and is equivalent to the net length and width of the boilers only

(7) The side walls of the cells are utilized as the boiler setting the arrangement accordingly being economical

Having briefly stated the advantages claimed for the design, we will now consider the practical working of the same —

Although one pair of cells with a boiler set between constitute "one unit" each cell must be regarded as isolated inasmuch as it cannot assist the other cell on the opposite side of the boiler It therefore follows that the actual supply of hot gases to the boiler cannot be constant in volume, and a considerable variation must inevitably result in the working conditions periodically

For instance when both cells are in full work the boiler will receive the maximum benefit, but when either of the two cells is being clinkered and newly charged the conditions at once materially change Instead of a hot volume of gases impinging

upon the boiler tubes from both cells, the hot volume comes from the active cell only and a cooler volume from the idle cell while the latter must of necessity reduce the efficiency of the former

It will be clear that during the period of clinkering and charging there must be one active cell and one idle cell alternately and it follows that the period of highest efficiency is reached when both cells are in full work This period of high efficiency cannot be constant because of the enforced inactivity of the cells in turn for clinkering and charging

That the arrangement of cells and boiler is compact will not be disputed as also the claim that the minimum of radiating surface is exposed It is also so far advantageous to have the boiler so set that it may be fired with coal either in conjunction with the Destructor gases or when the Destructor is idle

The practice of coal firing a boiler which is also being fired with Destructor gases has however been very severely criticized it being contended that the fuel efficiency of both the refuse and the coal is reduced materially owing to the inrush of cold air both through the open furnace doors when cleaning out or feeding fuel and also through the cell doors during clinkering and charging

The design however is sure to be favoured in the case of some combined electricity and Destructor works because it tends to reduce the capital cost As the Destructor boilers can be used for coal firing as desired it is often suggested that to begin with no extra boilers for separate firing shall be provided

The system for charging the refuse into the cells as already noted is unique and peculiar to this particular Destructor As the system is fully described in another chapter among other systems of charging it will accordingly suffice if the advantages which are claimed for the same are just briefly enumerated They are as follows —

(1) The carters get rid of their loads more quickly through having a clear fall from the cart to the refuse

(2) So long as storage space remains it can quickly be brought under the tail board of the cart

(3) The material is received from the cart and delivered direct to the cell without the intervention of hand labour

(4) None of the refuse as stored comes into contact with the heated surface of the cell

(5) The whole of the arrangements are operated from the upper winch platform, and the men need not go down among the material

(6) The quantity of material destroyed per day is greater than under the old system

(7) A reduction in the number of men employed as compared with the old system of ordinary top charging

(8) The whole arrangement can be kept in a clean state, and free from objection on sanitary grounds

The system of storage is undoubtedly cool and cleanly, but, as will be observed, the storage capacity is limited, and if refuse is delivered irregularly and carts arrive at such times as the charging trucks are full, storage in the carts is necessary to avoid extra handling of the material

In stating this, cart storage is not deprecated, it is a cool and sanitary system, the only objection being the necessity for providing extra carts, which, as pointed out in another chapter, is a special feature of Horsfall's and Meldrum's systems of direct charging

Records of actual work being done in many towns will be found tabulated herein, and these are worthy of careful perusal In the case of quite a number of installations where the power is being fully utilized for electric lighting electric traction and sewage pumping it will be observed that very satisfactory results are being obtained

The general design of the "Improved" Fryer type of cell, embodying Messrs Boulnois Wood and Brodie's patents is illustrated in Figs 19 and 20

WARNER'S "PERFECTUS" DESTRUCTOR

This Destructor possesses some few points in common with the "*Fryer*" type *The cells are, however larger, and a boiler* of the multitubular type is almost invariably used instead of a water tube boiler

The cells are usually arranged back to back excepting in the case of very small installations and top charging is an essential feature, small charging hoppers being provided immediately

over the drying hearth, the hopper base being just above the reverberatory arch over the hearth The hopper base plates

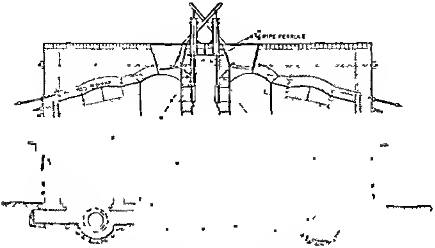


FIG 21 WARNER'S TOP FED DESTRUCTOR
Section through Pair of Cells

are hinged, and the opening and closing of the base plate as required is controlled by an arrangement of simple hand levers on top of the cells

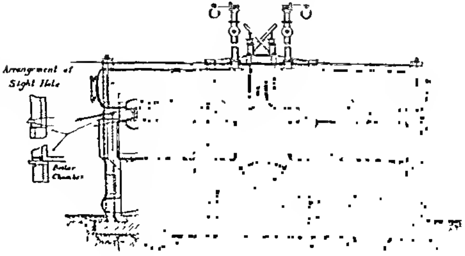


FIG. 22 WARNER'S DESTRUCTOR, TOP FED TYPE

The gases leave the cells at the side through an exhaust opening coming into immediate contact with the boiler. In all modern installations forced draught is provided, Sturtevant Fans driven by high speed vertical engines being usually employed.

Figs. 21 and 22 clearly indicate the general arrangement of two cells arranged back to back, these being of the ordinary top fed type, while Fig. 23 illustrates a later arrangement which provides for direct charging from cart to cell with storage in the cell.

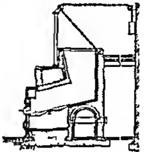


FIG. 23. WARNER'S DESTRUCTOR. DIRECT CHARGED TYPE.

It will be observed that this design is similar to Horsfall's system of direct charging, the refuse having to be manipulated from the front (i.e. the clinkering floor), and the same difficulties which were met with in Horsfall's original design are likely to be presented again with this system. As the difficulties inseparable from systems of cell storage are fully dealt with in another chapter, it is unnecessary to further discuss the same here.

The Warner Destructor as originally designed was somewhat similar to the early Fryer Destructor, the cells being erected either in single row or back to back, the boiler being placed between the cells and the chimney in the main flue. The later arrangement of setting a boiler between every two cells dates from 1892, about which time also forced draught was first introduced in connection with this particular make.

Although a considerable number of Warner Destructors have been erected, many are of the early type. Compared with some of the more recently introduced Destructors, no great headway has been made in the production of power.

HORSFALL'S DESTRUCTORS

The Horsfall Destructor will always be remembered as the first high temperature Destructor, and its advent marked a new era in the disposal of refuse by fire. Although the name of

Horsfall is always associated with the first high temperature Destructor yet the temperature obtained many years ago although high by comparison with the earlier low temperature natural draught Destructors was not so high as that now reached with the best of modern Destructors

That the advent of the high temperature Destructors gave an immense impetus to final and sanitary refuse disposal is beyond all question and it may be safely said that had we not yet adopted high temperature working in this country our own position to day in so far as sanitary Refuse Disposal is concerned would be no more satisfactory than is the case in America

As the pioneers of the high temperature system the Destructors made by the Horsfall Company are of peculiar interest At the present time no less than three distinct types of Destructors are associated with the name of Horsfall (1) Back shovel or hand fed type (2) The top fed type and (3) A system of direct charging from cart to cell this being a modification of the top fed type All three systems are fully described in the chapter dealing with the various systems of charging in use

It is not surprising that the first high temperature system should be popular and great credit is due to the makers not only for this valuable and far reaching innovation but also for improvements in design which have contributed not a little to the present satisfactory position of this country in so far as final and sanitary Refuse Disposal is concerned

To briefly refer to one feature in design which was generally admitted to be a great improvement—the front exhaust One has only to compare Figs 13 and 14 to at once appreciate the value of this improvement Instead of the gases as distilled from material on the drying hearth being permitted to at once pass out of the cell into the main flue the direction of exit was reversed the green gases being caused to travel over the active grate before leaving the cell and only passing from the cell into the exhaust flue intermingled with hot gases excepting of course at such times as the cell may be idle

Even those who doubt the utility of the drying hearth at all will admit that having a drying hearth the front exhaust is a

necessity Ten years ago, when critical comparison was frequently made between the earlier systems and this new departure those who had occasion to study the matter even superficially were speedily convinced as to its superiority Other features peculiar to the Horsfall Destructor, such as the side air boxes, are dealt with in another chapter, that these are useful for preventing the adhesion of clinker to the side walls of the cell has been amply demonstrated

Within the past two years, coincidently with the developments made in the production and utilisation of power from refuse the back shovel or hand fed type of cell would appear to have been more popular on the whole than the top fed type It may there fore, be of interest to quote Mr George Watson's conclusions concerning the relative advantages of the two systems —

> There is practically no difference between the two systems in regard to economy of labour The work at the front is similar for both types of furnace and consists in pulling the refuse forward and spreading it over the fire with a long handled iron rake [1]

It being admitted that back hand feeding possesses no economic advantages over top feeding its popularity must perforce be attributed to other considerations In the chapter discussing various systems of charging refuse into cells the author has endeavoured to show what the real advantages are

That the very best results recorded with the Horsfall Destructor are being obtained with installations of the back hand fed type is very evident By best results is meant efficiency in power generation and also the production of a good hard clinker

In order to clearly appreciate the difference in the design and arrangement of the top and back fed types it is necessary to compare Figs 9 and 13 Many installations of both the top and back fed types are herein described details of several evaporative tests are also included The reader will find much of interest therein and not only in connection with installations where the power is fully utilised

[1] Watson on *Refuse Furnaces* See *Proceedings of The Institution of Civil Engineers* vol cxxxv 1898 99 Part 1

MELDRUM'S "SIMPLEX" REGENERATIVE DESTRUCTOR

The first Destructor of this type was erected about nine years ago at Rochdale since which time various minor improvements have been adopted The main features, however, such as front feeding by shovel the continuous grate, and the regenerative system of air heating have all been retained and perfected

With the system of continuous grate and divided ashpits, the principle of "mutual assistance" is embodied in its entirety As will be seen by referring to Fig 24, instead of small ordinary cells divided one from the other one large furnace chamber is provided but below the grate divided ashpits are

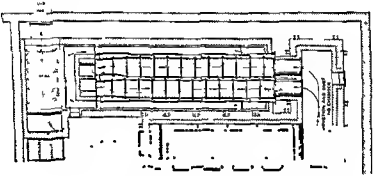


FIG 24 MELDRUM'S SIMPLEX REGENERATIVE DESTRUCTOR FRONT HAND OR SHOVEL FED TYPE
Plan showing Passage of Gases and Air for Combustion

arranged, each ashpit being provided with two steam jet blowers fitted into a downtake box communicating with the air conduit, which is common to the series of ashpits

This arrangement of blowers ensures silent working of the forced draught, and as the blowers in each ashpit have a separate steam connection, the fires on each section of the continuous grate area are under separate control

As usually arranged, the whole volume of gases have a sideway motion; thus the volume of gases passing from that section of the grate on the extreme left must pass over and intermingle with the hot gases proceeding from the other sections of the grate, the

whole volume of gases moving in the same direction towards the combustion chamber

When a fresh charge of refuse is introduced on to either of the two middle sections of the grate, with active sections on the right and left, the newly charged refuse quickly ignites in the zone of active fire Charging the section on the extreme right in its turn, the hot volume proceeding from the active three-fourths of the grate must pass over and intermingle with the comparatively small volume of cool gases distilling from the newly charged section

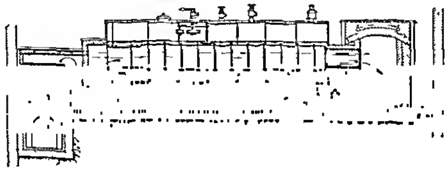


FIG 23 MELDRUM'S SIMPLEX REGENERATIVE DESTRUCTOR FRONT HAND OR SHOVEL FED TYPE
Elevation of Boiler and Regenerator

It will thus be seen that the cell is ever active, the example here illustrated is known as a four grate unit, three-fourths of the cell always being in full work With a three grate unit, two-thirds of the cell are always active and with a two grate unit one-half of the cell is always in full work

It is thus that a high temperature is maintained in the cell, the maintenance of high temperature being automatically secured To a great extent the use of hot air for combustion is also beneficial, quickly absorbing moisture and promoting rapid ignition Experiments with very wet refuse have shown that with cold air supplied to the blowers the fire would die out, while with air heated up to 300 Fahr rapid combustion could be maintained

As will be observed by referring to Fig 25, after the volume of hot gases leave the boiler they immediately pass through the regenerator or continuous air heater The regenerator consists of a battery of staggered cast iron pipes The hot gases pass vertically downwards through the pipes into the main flue, thence direct to the chimney unless an economizer be also provided

Cold air is admitted to, and circulates around the outside of the regenerator pipes, being drawn therefrom through an air conduit by the steam jet blowers which then force the volume through the fires The temperature of the gases after leaving the regenerator is sufficiently high to permit of an economizer being installed for heating the boiler feed water

It will thus be seen that having secured and maintained a high temperature in the cell, it is not only possible to generate steam in the boiler, but also to heat both air and water With such an arrangement some 1,600° Fahr will be absorbed between the combustion chamber and the chimney, the gases being reduced in temperature from about 2,000° Fahr to 400° Fahr

Although front hand or shovel feeding is usually associated with the particular Destructor we are now discussing, it will be seen by referring to Figs 15 and 16 that a system of top feeding can be used while still embodying the leading features of the continuous grate, combustion chamber and regenerator Similarly also a system of back shovel or hand feeding may be adapted, see Figs 10 and 11, likewise Marten's direct charging system as illustrated in Figs 7 and 8 It is unnecessary to here discuss the advantages of the various systems of charging, these being fully dealt with in a separate chapter.

The details of a number of evaporative tests made with Destructors of this type in various parts of the country, together with illustrations of steam pressure charts and temperature recorders, serve to clearly show that excellent results are being obtained, which are in no small measure due to the facilities provided for securing and maintaining a high temperature in the cell

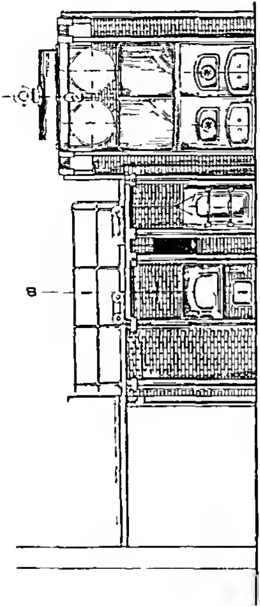


Fig 26 Meldrum's Beaman & Deas Type Destructor
Elevation

Meldrum's Beaman & Deas' Type of Destructor

This was one of the first high temperature Destructors, being

introduced at a time when but little progress had been made in the adoption of high temperature cells. About nine years ago, when the first installation was made many municipal engineers

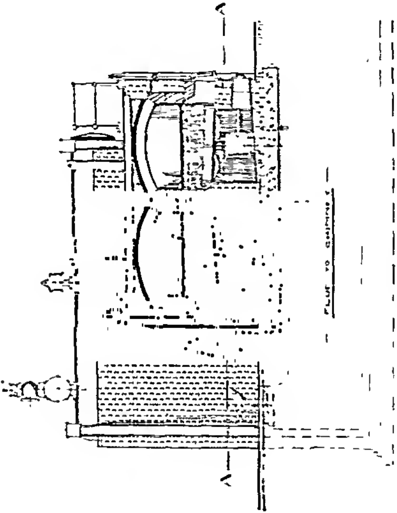


FIG. 27. MELDRUM'S "BEAMAN & DEAS" TYPE DESTRUCTOR. Part Elevation, part Section.

gravely doubted whether it was possible to secure the results then claimed.

Time, however, has but served to show that a temperature of 2,000° Fahr., which was then disputed, can be very easily

obtained, and likewise a combustion of 15 tons of refuse per cell per 24 hours can be readily exceeded.

In essential principles the Beaman & Deas type of Destructor is the same now as it was in the beginning, a few minor improvements have been introduced, all of which tend to facilitate the

FIG. 25. ... BEAMAN & DEAS TYPE DESTRUCTOR. Plan.

manipulation of the refuse when in the cell, and to improve the combustion thereof.

As usually arranged the Destructor in question comprises a pair of divided cells with a combustion chamber common to both cells, and a Babcock and Wilcox boiler set behind the same

bustion chamber The ordinary arrangement of the cells is shown in Figs 26 27 and 28 If desired the refuse may be contained upon a storage shoot or in a storage bin clear of the cells being dragged forward and charged in as required A further modification is the inclusion of Marten s system of direct charging which arrangement may be seen in Figs 7 and 8

The grate area of each cell is 25 square feet and a spacious drying hearth is provided at the end of the cell furthest from the combustion chamber so that green gases as distilled must pass over the active grate before entering the combustion chamber

Fan forced draught has always been employed and some very high rates of combustion have been reached In a test at St Helen s it will be noted that over 100 pounds of refuse was destroyed per square foot of grate surface per hour

The provision of a common combustion chamber with the alternate system of charging ensures the mixing of the gases in the combustion chamber and each cell in its turn is therefore helpful to its neighbour Direct access is given to the drying hearth and from this point the refuse is pushed forward as required and spread over the grate The cell is clinkered from the side and a reasonable concentration of labour is thus secured

As a top fed system embodying the drying hearth and fan draught it will be found interesting to compare the results with those obtained with other Destructors of the top fed type

Baker s Improved Destructor

This Destructor was introduced about four years ago and up to the present so far as this country is concerned the practical working of the same has to be judged by one example only a two cell plant erected at Phoenix Wharf Lambeth under the Metropolitan Borough of Finsbury

Internally this Destructor differs essentially from all other British makes Two inclined grates are provided one above the other The cells being charged at the top the refuse immediately falls on to the upper grate which constitutes the drying hearth At the opposite end of this grate access doors are provided for

the manipulation of the material on the upper hearth or grate and from this point it is dragged forward over the end of the grate as required and again spread over the secondary inclined grate beneath

In contra distinction to all other systems with which drying hearths are used, with this type all fumes from the drying hearth

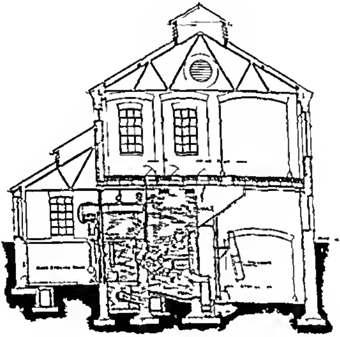


FIG 29 BAKER'S IMPROVED DESTRUCTOR

e exhausted by the forced draught fan and delivered with the r supply under the secondary grate This is a good feature, nasmuch as it entirely avoids the neutralizing effect upon the ll temperature which must obtain when low temperature gases re constantly being liberated in a cell where active combustion s also in progress By this is meant single cell systems with hich the drying process is constant in every cell

Fig 29 clearly illustrates the general design, it will be observed hat considerable depth is demanded and further that the opera

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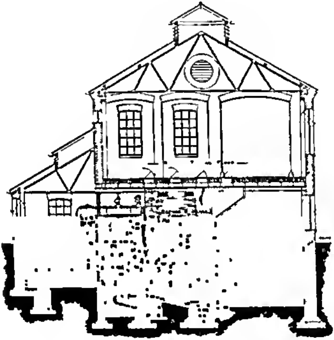

FIG. 29 BAKER'S IMPROVED DESTRUCTOR

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Fig 29 clearly illustrates the general design, it will be observed that considerable depth is demanded and further that the opera-

tion of the cell necessitates labour at three different levels (*A*) on top of for charging (*B*) intermediate stoking at the back and (*C*) levelling and clinkering below at the front This is not a satisfactory feature as it prevents that concentration of labour which is always a source of economy

Whether the very ample cell storage will prove satisfactory yet remains to be seen past experience would incline one to think that difficulties will be presented owing to the swelling action of the heat radiated from below and also because of the great weight of material above a somewhat restricted opening at the hopper base

There are many novel features embodied in the design and it will be interesting to clearly follow the results obtained in actual practice The plant here illustrated differs considerably from the one working example in London mainly perhaps in the provision for storage of refuse in the cell a departure which has always involved trouble wherever yet tried in addition to increasing the labour cost

The Sterling Refuse Destructor

This Destructor which was introduced about three years ago is not unlike the Beaman and Deas type in general design and has given very satisfactory results

The cells are usually erected in pairs the combustion chamber being placed between two cells whereas with the Beaman and Deas type the combustion chamber is arranged at the back of the cells and between the cells and the boiler

In the case of larger installations while the pair system is still retained with the cells the arrangement is such that either 4 or 6 cells discharge their gaseous products into one combustion chamber

Each cell is provided with a drying hearth the grate proper having an area of 25 square feet Fan draught is always employed and usually Babcock and Wilcox boilers are set in connection with the cells in preference to any other type of boiler

The storage of refuse in carts is recommended but as already

pointed out in another chapter, this system of storage has commended itself to but few authorities up to the present, owing to the increased capital expenditure involved

In the case of one or two installations, a system of transporters and storage bins has been provided, notably at Hackney and Aston Manor Some actual working results obtained with these and other installations are referred to elsewhere and these are worthy of careful perusal

HEENAN'S 'TWIN CELL' DESTRUCTOR

This Destructor was introduced about three years since being at that time a modification of the "Bennett Phythian"

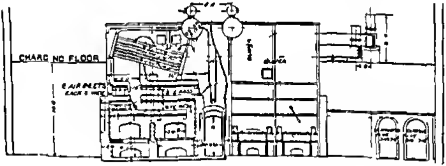

FIG 30 HEENAN'S TWIN CELL DESTRUCTOR

Destructor The essential principle of the Destructor is conveyed to the reader in the term Twin Cell and the modifications of the original type have all in the main been introduced with a view to securing and maintaining a high temperature in the cell

To some extent the design has been simplified and while this has been accomplished it has not involved any sacrifice in general efficiency As will be observed by referring to Fig 30 cells are erected in pairs and while each cell has its separate ashpit the two cells form one continuous chamber divided

only above the grate level by a shallow bridge between each grate

Each cell has a grate area of 30 square feet, and as with Meldrum's system of continuous grate, so with the system we are discussing a drying hearth is not used Forced draught is provided by means of centrifugal fans, either electrically or steam driven and hot air is supplied for combustion, the air being heated in passing through a continuous air heater, known as Howden's system, which method of air heating has been extensively used in connection with forced draught for marine boilers

In the case of the earlier installations the refuse was tipped direct from the cart into a back storage hopper, from which the material was dragged over the grate by means of a rake, this operation being performed from the clinkering floor immediately opposite The Heenan "Twin Cell" Destructor may therefore be termed a back fed Destructor (see Fig 12)

While the charging of refuse into a closed storage hopper has its advantages it will be clear to the reader that the hopper feed is always liable to give trouble, for reasons already indicated

When the material becomes hot, and accordingly swells, it is difficult to move, and when it is only possible to manipulate the mass from one point, and that by dragging from a distance, the disadvantages of hopper charging at once become evident

Even when refuse is cool, it will constantly "bridge" over in wide hoppers, it is then dangerous to attempt to dislodge the mass from below even if it is accessible from the underside To break through the same from above is often found very difficult, and when dislodged the impact of the fall is such as to compress the mass at the hopper base

It would appear that the makers of the Heenan "Twin Cell" Destructor clearly appreciate the difficulties involved in the hopper feed, as they have recently introduced a charging ram which is arranged to push the refuse forward from the base of the hopper (see Figs 17 and 18) This method of charging is further discussed in another chapter

That the Heenan Destructor has been successful, may be

mainly attributed to the design and the use of hot air for combustion. The principle of "mutual assistance" has been kept carefully in mind and embodied in the design, with the result that the system has quickly become popular.

only above the grate level by a shallow bridge between each grate.

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Chapter VI

LABOUR COST

THE labour cost in connection with Destructors is a factor of great importance and demands careful consideration but it is a great mistake to single this one factor out as the main or only basis for comparison between two or more systems

Being a standing charge it calls for serious attention but it is obviously absurd to lay down the principle that because with one system it is guaranteed to destroy refuse at 8d per ton as against 10d per ton guaranteed with another system the former is of necessity the most economical With the latter plant twice as much steam may be guaranteed or the clinker may in the one case be poor and in the other case vitreous and commercially speaking very much more valuable

Again the question of depreciation is a factor which must be recognized recent reports serve to clearly show that with some systems the cost of repairs is considerably higher than others It will thus be evident that a possible economy in bare labour cost for destruction should not be considered apart from various other factors

The writer has in instance in mind of two recent installations of the high temperature type in a Northern city Both Destructors are of the top feed type but the systems are different the two installations are scarcely two miles apart and yet in one case the whole of the clinker is disposed of at 2s 6d per ton at the works while in the other case the clinker is valueless and produces practically nothing

This case is not an isolated one, nor is it overdrawn At the present time and for some three years past in connection with a Destructor in one of the Metropolitan Boroughs, the clinker is freely disposed of on the premises at 1s 9d per cubic yard Five miles away, in another Metropolitan Borough with a different type of Destructor, not only is the clinker too soft to command a market, but at least 2s per ton has to be paid to get rid of it

Instances such as these only too clearly show that in this respect alone it might be wise to choose one type of Destructor rather than another, even if the guaranteed labour cost was higher

If for purposes of argument we assume that 3 of a penny is a fair price to fix as the value of each unit of electricity generated, and that a ton of average refuse is equal to the production of 30 electrical units such refuse then has a fuel value of 10d per ton If one maker guarantees this output and a labour cost of 10d per ton while another maker only guarantees 15 units at a labour cost of 8d it will be easy to determine which will be the best investment for the authority and accordingly for the ratepayers

Experience generally shows also that where the greatest amount of power is produced there also is the best clinker produced, so that on the whole a guaranteed low labour cost must be closely investigated and only considered with a full knowledge of the other important factors involved

In the case of a sewage works where it is proposed to erect a Destructor it may be desirable to utilise the clinker for bacteria beds This being so the very best clinker is essential and in every such case if necessary it would be policy to pay even some few pence per ton extra for labour cost to ensure the production of suitable clinker

The broader issues must receive consideration mere labour cost *alone* is deceptive it is of the highest importance that the whole of the factors be taken into account If this be done then that which at first sight appears to be advantageous may be very seriously discounted even if not entirely obliterated It is necessary to emphasize the importance of this because so much

has been said and written concerning phenomenally low labour cost that far too much importance may attach to what is only after all *a* factor

There is ample evidence available to clearly show that even with refuse practically uniform in composition, some Destructors are very much more satisfactory than others in power production and also in the quality of the residuum Difference in design will to a large extent account for this the higher and more equable the temperature the greater and more satisfactory is the power production and the more vitreous the clinker

It is quite possible for two modern Destructors of different types in one town to show very different results in steam raising and also a residuum differing in character and accordingly in value Although this may be doubted by the layman it is nevertheless a fact nor is it remarkable when one looks carefully into the matter critically comparing the difference in design and general arrangement

Destructor makers are often invited to guarantee the cost ... ith labour when they are not at all familiar with the rate of wa... as ruling in the town and as the various systems are so differ... the not only in the methods of charging but also n the rate of c... ter bustion or guaranteed capacity per cell ...anteed ... er much fairer form of guarantee ... e other case vitreous and invited to state how many ... uch more valuable man in a shift of 8 or ... depreciation is a factor which must To ask for a gu... it reports serve to clearly show that with is often to ask f... cost of repairs is considerably higher than others the Destruct... evident that a possible economy in bare labour what is b... truction should not be considered apart from various wages pa...s various ... riter has an instance in mind of two recent installations table ... gh temperature type in a Northern city Both Destruc... of the top feed type but the systems are different, the ...nstallations are scarcely two miles apart and yet in one the whole of the clinker is disposed of at 2*s* 6*d* per ton at works while in the other case the clinker is valueless and ...uces practically nothing

Comparative Statement Showing Rate of Wages Paid and Number of Hours Worked Weekly in connection with Refuse Destructors in 28 Boroughs[1]

Name of Town	Stokers Wages per Hour	Chargers Wages per hour	Number of Hours worked per week Stokers	Number of Hours worked per week Chargers
Bradford	7d	6¼d	48	48
Birkenhead	6 5d & 7d	4 52d & 4 91d	48	61
Birmingham	6 5d & 7d	5 75d & 6d	48	48
Blackburn	6d	—	54 & 60	—
Bolton	5 58d	—	58	—
Bristol	7 73d & 8 4d	—	45	—
Burnley	6 5d	5 5d	48	48
Bury	5 5d	—	60 & 74	—
Colne	6d	5 5d	55	50
Darwen	6 5d	—	72	—
Derby	4 64d & 5 03d	4 64d & 5 03d	62	62
Edinburgh	7 5d	7d	48	48
Glasgow	4 75d & 4 95d	—	58	—
Hyde	5 15d	5d	55½ & 50½	56 & 50
Huddersfield	5 5d	5 5d	60	60
Leeds	7 75d	—	48	—
Liverpool	5 45d	4 54d	66	66
Manchester	5 75d	—	58	—
Nelson	6d	5 5d	65	61½
Newcastle on Tyne	5 62d	5 62d	56	56
Oldham	7 5d	—	48	
Preston	5 58d	4 98d	58	58
Rochdale	7 25d & 6 5d	—	44	
Salford	5 35d	4 71d	56	56
Sheffield	6 75d	6 25d	48	48
St Helens	6d	5 33d	54	54
Warrington	5 14d	3 8d	63	63
Wigan	5 72d		64½	

It will be observed that the stokers' wages vary from 4 64d per hour at Derby to 7 75d at Leeds and even as high as 8 4d at Bristol, it is therefore obvious that if a Destructor of the same

[1] Compiled by the late Mr John M Taggart of Bradford

type as that in use in Leeds were installed in Derby the labour cost for destruction would be substantially the same and it therefore follows that if the Derby Destructor is operated at a much lower labour cost per ton destroyed than is the case at Leeds then such a difference in favour of the Derby plant is no argument in favour of the particular type of Destructor in use there but on the other hand may be entirely attributed to the cheaper labour available

It is very necessary that this should be borne in mind because the controlling factor in any one town must inevitably be the rate of wages paid in that town It will be clearly seen by referring to the tabulated statement that the rate of wages paid per hour in different parts of the country for practically the same class of work varies between fairly wide limits

Some few years since it was urged that the labour cost for destruction would be very much higher if the power was fully utilized than was the case where the refuse was merely destroyed without any attempt being made to utilize the heat

As with other more or less plausible theories advanced at the same time so with this experience has clearly shown the exact contrary to be the case and if careful averages be taken it will be seen that even in the *gross* labour cost the modern Destructor combined with a power plant is no more costly for the labour involved in actual destruction than is the case with the Destructor pure and simple

Then if the value of the power produced be taken into consideration the theorist must at once admit that his calculation was very wide of the mark the *net* labour cost for destruction being so low that even the most rabid partisan must allow that it is wanton waste to discharge high temperature gases into a chimney without any attempt at utilization

With the great developments in the mechanical handling of material of every kind there has been a constant demand for some mechanical means of handling refuse Although great stress is at times laid upon the sanitary advantages accruing from mechanical handling of refuse the underlying motive has unquestionably been a desire for reducing the labour cost

Generally speaking, up to the present time mechanical apparatus for handling refuse has but a poor record, not being altogether successful from the sanitary standpoint, and certainly showing no advantage in reduced labour cost

To briefly deal with the sanitary aspect first, average refuse is of such composition that it is impossible to feed every portion into a cell Old galvanized baths and pails are frequently met with, also large earthenware utensils and large tins It is essential that these should be picked out, being not only useless for power production, but tending to choke the fire Such articles are more easily handled when cold than after being in the cell, therefore a certain amount of handling is necessary

To this extent mechanical handling is not final and, as is explained in another chapter, expeditious mechanical or direct charging involves greater labour below on the clinkering floor than is the case with ordinary systems of charging

If the actual charging process represented the *whole* of the work involved, if picking over the material were entirely avoided, if the one operation of charging the *whole* of the refuse in at the top or back of the cell, as the case may be, were practicable and final, then the process would be perfect from a sanitary point of view and undoubtedly very low in labour cost

However, this is not so, and in addition to the sorting process, the mechanical handling of such material in transporters or conveyors—the tipping from one receptacle to another—means a dust-charged atmosphere quantities of dust being liberated and contributing in no small degree to the discomfort of the staff

Mr John Brodie, A M I C E the eminent City Engineer of Liverpool in a paper read at the Liverpool Congress of the Sanitary Institute on September 25 1894 made the following observations concerning the handling of refuse by conveyors etc

Experience with this class of material shows that owing to its varying nature as received from the carts, difficulties arise when attempts are made to deal with it by means of tapered hoppers and that it is usually quite unsuited for conveyance on mechanically moved bands or conveyors, unless the larger and more stringy materials are first removed.

The extraordinary high labour cost in connection with such systems is an all sufficient answer to those who insist that labour is reduced. Some of the figures here quoted are alarming and almost incredible but in every instance they have been taken from official returns and may therefore be accepted as authentic.

It is true that nine years have elapsed since Mr Brodie clearly expressed the very limited utility of mechanical apparatus for handling refuse but refuse is quite as extraordinary in composition now as it was then even if not more so. That curious medley which goes to make up average civic waste defies satisfactory handling by means of any apparatus devised for handling an unvarying material; a roll of linoleum may be followed by some loose straw and some garbage or garden waste by a disused bath or mattress, refuse being anything but homogeneous in character.

The economy in labour which results from the employment of conveying apparatus for homogeneous material is largely due to the automatic character of the installation and because the minimum of labour and attention is required. With refuse it is impossible to rely upon automatic charging or discharging and thus to a large extent the utility of the conveyor is not realized.

It is idle to disguise the fact that unless an installation of this kind in connection with a Refuse Destructor fulfils its object which is primarily an economic one it is an unwarranted waste of public money. Mechanical handling of refuse will doubtless always appeal to the lay mind but this will not do unless the economic desideratum be realized the system cannot be deemed satisfactory.

It has been suggested that the class of labour employed in connection with Destructors is the very lowest—the dregs of the labour market and further that it is a difficult matter to obtain the necessary men. It would be idle to pretend that every stoker and charger is a man of refinement but as a class they are respectable and will favourably compare with those engaged in other more pleasant occupations and earning a similar wage. To suggest that the men engaged in disposing of civic waste are the dregs of the labour market is absolutely untrue and it is

a libel on a body of men whose toil is arduous and whose wage is well earned

Although the work is not of a pleasant character yet there is no scarcity of labour, nor is there any sign that such will be the case It is true that wages have an upward tendency, but is not this also the case all round? With an advancing wage a greater quantity of refuse is dealt with per man, and so the labour cost does not increase in the same ratio

The late Charles Kingsley once said that those who have to do with the disposal of the waste of a community should be the best paid members of the community While perhaps but few would be inclined to agree with the great poet and novelist, yet it will be generally conceded that such an occupation deserves at least a good living wage

Generally speaking the working hours are reasonable and a living wage is paid[1] According to the tabular statement prepared by the late Mr John McTaggart of Bradford early in 1901, the averages of 27 destructor installations work out as follows—

Number of Hours worked weekly—	
Stokers	56.28 hours
Chargers	57.00 "
Mortar Mill Men	54.34 "
Yard Men and Labourers	54.82 "
Rate of Wages per hour—	
Stokers	6.12*d*
Chargers	5.18*d*
Mortar Mill Men	5.51*d*
Yard Men and Labourers	5.11*d*

Eight hour shifts are becoming increasingly popular and it may be reasonably urged that an eight hour day for the class of work in question is sufficiently long In a few towns however, 12 hour shifts are worked *Darwen is a case in point* but here this question was decided by the men themselves with the result that they earn 39s each for a week of 72 hours—six 12 hour shifts day and night shifts being taken in alternate weeks

[1] See *The Surveyor and Municipal and County Engineer*, April 26, 1901

On the whole it may be said that in spite of the admittedly unpleasant nature of the work and the fact that there are systems in use ranging from simple hand or shovel feeding to an elaborate and complex system of mechanical handling, there is no labour problem to be faced

Notwithstanding the fact that a wide difference exists between the old type of Destructor, pure and simple, and its modern and perfected prototype combined with an Electricity Station, Sewage Works or Water Works yet year after year the work proceeds smoothly and labour troubles are practically unknown

It has been suggested that instead of paying a fixed rate per hour or per shift to stokers, that they be paid so much per ton of refuse passed through the cells In one or two towns this system has been introduced and on the whole it appears to work satisfactorily but as a general rule such systems cannot be recommended

Unless the supervision is of the very best there is a constant danger of the primary object of the Destructor being thwarted the men are naturally anxious to earn as much as possible in a shift and "rushing" the fires may be resorted to with the result that the clinker is not only too soft for utilization but is also very offensive

While this system of payment may have the effect of inducing smarter work in charging and clinkering and so may conduce to steadier steaming if the primary purpose of the Destructor be not fulfilled it is not worth consideration The payment of a fixed rate per hour obviously does not call for the maximum of effort, but it does conduce to a regular cycle of operations which is of the very highest importance

Needless to add, clockwork regularity is an essential and should be insisted upon Adequate control of labour and careful management is of the highest importance In one town a bonus is given to the men for every ton destroyed in excess of a given quantity, and although in this particular case the result has been entirely satisfactory, yet on the whole it is a system which cannot be recommended for general adoption

The great danger under such a system is precisely the same

as that already indicated when the weight of refuse dealt with forms the basis of remuneration. A given weight of average refuse demands a certain period for proper treatment *within the cell*, and nothing should be allowed to influence "rushing" tactics. Each man should handle a given weight of refuse per shift and no more, and no incentive should be offered to stimulate an energy which may defeat the primary purpose of the Destructor.

Although, as already observed, labour cost is but *one* factor among many, yet it is of interest to review actual costs now obtaining. The various figures here quoted while being of great interest are of necessity somewhat at variance inasmuch as, although in every case they apply to bare labour cost only, yet the conditions obtaining are in some instances antagonistic to low labour cost, while in other cases the conditions are eminently favourable thereto.

The analyses quoted are, however, of general interest, and they will serve to explode some few fallacies. Further, such figures not being those quoted by Destructor makers will have the effect of clearly placing before the student of the subject reliable data.

This statement is not intended to cast any reflection upon the figures quoted by Destructor makers, but it should be borne in mind that such figures as a general rule refer to tests only, and not to extended periods of working under normal conditions.

Generally speaking tests are conducted under more or less artificial conditions and therefore a labour cost demonstrated during a short test may be very misleading. It is for this reason that in the compilation of the labour costs here quoted test figures, (unless confirmed by actual working experience) have been omitted.

Taking Destructor installations and grouping the same as follows, we get the undermentioned averages—

(a) Top Fed Systems. (6 Makes.)

The average of 85 installations gives a labour cost of 13.54 pence per ton.

(b) Direct or mechanical charging systems. (4 Makes.)

The average of 9 installations gives a labour cost of 14.83 pence per ton.

(c) Shovel or Hand Fed type (2 Makes)

The average of 25 installations gives a labour cost of 1s per ton. 17 installations, *Front* Shovel or Hand Fed type, give an average labour cost of 10·88 pence per ton and 8 installations of the *Back* Shovel or Hand Fed type give an average labour cost of 14⅜ pence per ton

(d) London and District (6 Makes)

The average of 12 installations gives a labour cost of 11·01 pence per ton

(e) Installations with which the power is fully utilized

The average labour cost at 44 such works is 13·07 pence per ton

(f) Installations of old types and others where the power is not fully utilized

The average labour cost at 68 such works is 13·10 pence per ton

It is but fair to state that in a few instances the labour cost is abnormal owing to the quantity of refuse to be destroyed being in excess of the weight which could be dealt with in one shift but still insufficient to keep the staff fully employed for two shifts

At Padiham where the labour cost is given as 2s 10*d* per ton this is the case as also at Aldershot where the whole of the refuse is destroyed in one and a half shifts = 18 hours daily, but wages have to be paid for the two shifts (24 hours) The labour cost at Aldershot being 1s 1*d* per ton, it will be clear that the labour cost is 25 per cent more than it should be

To put the case another way if sufficient refuse were available at Aldershot 25 per cent extra weight could be burned for the same wages cost daily and this would have the effect of reducing the labour cost to 9·75*d* per ton

The following table of labour cost has been compiled with every possible care, and may be said to represent present practice—

ENGLAND AND WALES

	s	d
Accrington	1	5
Aldershot	1	1
Ashton under Lyne	0	11 66
Aston Manor	0	11
" " (2 Makes)	0	11
Bangor	1	4
Barry	1	3 50

	s. d
Bath	1 3
Batley	1 6
Beckenham	1 9
Birkenhead	0 10 21
„ (2 Makes)	0 10 21
Birmingham	0 9 82
Blackburn	0 10
„ (3 Makes)	0 11
„	0 10 50
Blackpool	1 6 50
Bolton	0 10
Bournemouth	0 9
Bradford	0 9
Brighton	1 7
Bristol	0 11 50
Burslem	1 5
Burton on Trent	1 4
„ „ (2 Makes)	1 4
Bury	0 10 8
Buxton	0 11
Cambridge	1 3
Canterbury	1 0 086
Cheltenham	0 7 6
Chesterfield	0 7 6
Colne	0 10 50
Darwen	1 0
Dewsbury	1 1 75
Gloucester	0 10
Grays	0 10
Handsworth	0 10 75
Hartlepool	0 11
Hastings	1 6 75
Heckmondwike	1 0
Hereford	0 9
Huddersfield	0 10 50
Hull	1 3
Hunstanton	1 0
Hyde	1 2
Lancaster	1 4
Leeds	0 10 25
„ (2 Makes)	0 10 25
Leicester	0 8 25
Leyton	1 7
Liverpool	0 8 25
Llandudno	1 3 25
Longton	0 11
„ (2 Makes)	0 11

(c) *Shovel or Hand Fed type* (2 Makes)

The average of 25 installations gives a labour cost of 1*s* per ton, 17 installations *Front* Shovel or Hand Fed type give an average labour cost of 10.88 pence per ton and 8 installations of the *Back* Shovel or Hand Fed type give an average labour cost of 14⅝ pence per ton

(d) London and District (6 Makes)

The average of 12 installations gives a labour cost of 16.01 pence per ton

(e) Installations with which the power is fully utilized

The average labour cost at 14 such works is 13.07 pence per ton

(f) Installations of old types and others where the power is not fully utilized

The average labour cost at 68 such works is 13.10 pence per ton

It is but fair to state that in a few instances the labour cost is abnormal owing to the quantity of refuse to be destroyed being in excess of the weight which could be dealt with in one shift but still insufficient to keep the staff fully employed for two shifts

At Padiham where the labour cost is given as 2*s* 10*d* per ton this is the case, as also at Aldershot where the whole of the refuse is destroyed in one and a half shifts — 18 hours daily, but wages have to be paid for the two shifts (24 hours) The labour cost at Aldershot being 1*s* 1*d* per ton it will be clear that the labour cost is 25 per cent more than it should be

To put the case another way, if sufficient refuse were available at Aldershot, 25 per cent extra weight could be burned for the same wages cost daily, and this would have the effect of reducing the labour cost to 9.75*d* per ton

The following table of labour cost has been compiled with every possible care, and may be said to represent present practice—

ENGLAND AND WALES

	s	*d*
Accrington	1	5
Aldershot	1	1
Ashton under Lyne	0	11.66
Aston Manor	0	11
" (2 Makes)	0	11
Bangor	1	4
Barry	1	3.50

	s.	d.
Bath	1	3
Batley	1	6
Beckenham	1	0
Birkenhead	0	10 21
„ (2 Makes)	0	10 21
Birmingham	0	9 82
Blackburn	0	10
„ (3 Makes)	0	11
„	0	10 50
Blackpool	1	6 50
Bolton	0	10
Bournemouth	0	9
Bradford	0	9
Brighton	1	7
Bristol	0	11 50
Burslem	1	5
Burton on Trent	1	4
„ „ (2 Makes)	1	4
Bury	0	10 8
Buxton	0	11
Cambridge	1	3
Canterbury	1	0 980
Cheltenham	0	7 0
Chesterfield	0	7 0
Colne	0	10 50
Darwen	1	0
Dewsbury	1	1 75
Gloucester	0	10
Grays	0	10
Handsworth	0	10 75
Hartlepool	0	11
Hastings	1	6 75
Heckmondwike	1	0
Hereford	0	9
Huddersfield	0	10 50
Hull	1	3
Hunstanton	1	0
Hyde	1	2
Lancaster	1	4
Leeds	0	10 25
„ (2 Makes)	0	10 25
Leicester	0	10 25
Leyton	0	8 25
Liverpool	1	7
Llandudno	0	8 25
Longton	1	3 25
„ (2 Makes)	0	11
	0	11

COMPARATIVE STATEMENT SHOWING RATE OF WAGES [illegible] AND NUMBER OF HOURS WORKED WEEKLY IN CONN[illegible] WITH REFUSE DESTRUCTORS IN 28 BOROUGHS[1]

Name of Town	Stokers Wages per Hour	Chargers Wages per hour	Number of hours worked per week Stokers	[illegible]
Bradford	7d	6½d	48	[illegible]
Birkenhead	6 5d & 7d	4 52d & 4 91d	48	[illegible]
Birmingham	6 5d & 7d	5 75d & 6d	48	[illegible]
Blackburn	6d	—	54 & 60	
Bolton	5 58d	—	[illegible]	
Bristol	7 73d & 8 4d	—	[illegible]	
Burnley	6 5d	5 5d	48	[illegible]
Bury	5 5d	—	60 & 74	
Colne	6d	5 5d	[illegible]	[illegible]
Darwen	6 5d	—	[illegible]	
Derby	4 64d & 5 03d	4 64d & 5 03d	62	[illegible]
[illegible]dinburgh	7 5d	[illegible]d	48	[illegible]
[illegible]lasgow	4 75d & 4 95d	—	[illegible]	
[illegible]yde	5 15d	5d	[illegible]	[illegible]
[illegible]uddersfield	5 5d	5 5d	60	[illegible]
[illegible]eeds	7 75d	—	48	
[illegible]iverpool	5 45d	4 54d	[illegible]	[illegible]
[illegible]anchester	5 75d	—	[illegible]	
[illegible]elson	6d	5 5d	[illegible]	[illegible]
[illegible]ewcastle-on-Ty[illegible]	5 62d	5 62d	[illegible]	[illegible]
[illegible]	7 5d	—	48	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]dale	7 2[illegible] & 6 [illegible]	—	[illegible]	
[illegible]	5 [illegible]	4 71d	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	48	[illegible]
[illegible]	6d	[illegible]	[illegible]	[illegible]
[illegible]	5 14d	[illegible]	[illegible]	[illegible]
	5 72d		[illegible]	

[illegible] be observed that the stokers' wages vary from 4 [illegible] at Derby to 7 75d at Leeds and even as high as 8 4d [illegible] it is therefore obvious that if a Destructor of the sa[illegible]

[1] [illegible] by the late Mr [illegible] M Ta[illegible]art of Bradford [illegible]

type as that in use in Leeds were installed in Derby the labour cost for destruction would be substantially the same, and it therefore follows that if the Derby Destructor is operated at a much lower labour cost per ton destroyed than is the case at Leeds, then such a difference in favour of the Derby plant is no argument in favour of the particular type of Destructor in use there, but, on the other hand, may be entirely attributed to the cheaper labour available.

It is very necessary that this should be borne in mind because the controlling factor in any one town must inevitably be the rate of wages paid in that town. It will be clearly seen by referring to the tabulated statement that the rate of wages paid per hour in different parts of the country for practically the same class of work varies between fairly wide limits.

Some few years since it was urged that the labour cost for destruction would be very much higher if the power was fully utilised than was the case when the refuse was merely destroyed without any attempt being made to utilise the heat.

As with other more or less plausible theories advanced at the same time, so with this, experience has clearly shown the exact contrary to be the case, and if careful averages be taken it will be seen that even in the case of labour cost the modern Destructor combined with a power plant is no more costly for the labour involved in actual destruction than is the case with the Destructor pure and simple.

Then if the value of the power produced be taken into consideration, the theorist must at once admit that his calculation was very wide of the mark, the net labour cost for destruction being so low that even the most rabid partisan must allow that it is wanton waste to discharge high temperature gases into a chimney without any attempt at utilisation.

With the great developments in the mechanical handling of material of every kind there has been a constant demand for some mechanical means of handling refuse. Although great stress is at times laid upon the sanitary advantages accruing from mechanical handling of refuse, the underlying motive has unquestionably been a desire for reducing the labour cost.

Generally speaking up to the present time mechanical apparatus for handling refuse has but a poor record not being altogether successful from the sanitary standpoint, and certainly showing no advantage in reduced labour cost

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To this extent mechanical handling is not final and as is explained in another chapter, expeditious mechanical or direct charging involves greater labour below on the clinkering floor than is the case with ordinary systems of charging

If the actual charging process represented the *whole* of the work involved if picking over the material were entirely avoided, if the one operation of charging the *whole* of the refuse in at the top or back of the cell, as the case may be, were practicable and final then the process would be perfect from a sanitary point of view and undoubtedly very low in labour cost

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It is true that nine years have elapsed since Mr. Brodie clearly expressed the very limited utility of mechanical apparatus for handling refuse, but refuse is quite as extraordinary in composition now as it was then, even if not more so. That curious medley which goes to make up average civic waste defies satisfactory handling by means of any apparatus devised for handling an unvarying material; a roll of linoleum may be followed by some loose straw and some garbage or garden waste by a disused bath or mattress, refuse being anything but homogeneous in character.

The economy in labour which results from the employment of conveying apparatus for homogeneous material is largely due to the automatic character of the installation, and because the minimum of labour and attention is required. With refuse it is impossible to rely upon automatic charging or discharging, and thus to a large extent the utility of the conveyor is not realized.

It is idle to disguise the fact that unless an installation of this kind in connection with a Refuse Destructor fulfils its object, which is primarily an economic one, it is an unwarranted waste of public money. Mechanical handling of refuse will doubtless always appeal to the lay mind, but this will not do; unless the economic desideratum be realized the system cannot be deemed satisfactory.

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Generally speaking the working hours are reasonable and a living wage is paid [1] According to the tabular statement prepared by the late Mr John McTaggart of Bradford early in 1901 the averages of 27 destructor installations work out as follows—

Number of Hours worked weekly—	
Stokers	[illegible]28 hours
Chargers	57 00
Mortar Mill Men	54 74
Yard Men and Labourers	54 82
Rate of Wages per hour—	
Stokers	[illegible]
Chargers	18d
Mortar Mill Men	5d
Yard Men and Labourers	[illegible]

Eight hour shifts are becoming increasingly popular and it may be reasonably urged that an eight hour day for the class of work in question is sufficiently long In a few towns however 12 hour shifts are worked Darwen is a case in point but here this question was decided by the men themselves with the result that they earn 39s each for a week of 72 hours—six 12 hour shifts day and night shifts being taken in alternate weeks

[1] See *The Surveyor and Municipal and County Engineer* April 2[illegible] 1901

On the whole it may be said that in spite of the admittedly unpleasant nature of the work and the fact that there are systems in use ranging from simple hand or shovel feeding to an elaborate and complex system of mechanical handling there is no labour problem to be faced.

Notwithstanding the fact that a wide difference exists between the old type of Destructor pure and simple and its modern and perfected prototype combined with an Electricity Station, Sewage Works or Water Works, yet year after year the work proceeds smoothly and labour troubles are practically unknown.

It has been suggested that instead of paying a fixed rate per hour or per shift to stokers that they be paid so much per ton of refuse passed through the cells. In one or two towns this system has been introduced and on the whole it appears to work satisfactorily but as a general rule such systems cannot be recommended.

Unless the supervision is of the very best there is a constant danger of the primary object of the Destructor being thwarted; the men are naturally anxious to earn as much as possible in a shift and "rushing" the fires may be resorted to with the result that the clinker is not only too soft for utilization but is also very offensive.

While this system of payment may have the effect of inducing smarter work in charging and clinkering and so may conduce to steadier steaming, if the primary purpose of the Destructor be not fulfilled it is not worth consideration. The payment of a fixed rate per hour obviously does not call for the maximum of effort but it does conduce to a regular cycle of operations which is of the very highest importance.

Needless to add clockwork regularity is an essential and should be insisted upon. Adequate control of labour and careful management is of the highest importance. In one town a bonus
sto ... ver ... charger is ... every ton destroyed in excess of a given
are respectable and wil... in this particular case the result has been
in other more pleasant ... on the whole it is a system which cannot
To suggest that the m... eral adoption
are the dregs of the labo... ter such a system is precisely the same

as that already indicated when the weight of refuse dealt with forms the basis of remuneration. A given weight of average refuse demands a certain period for proper treatment *within the cell*, and nothing should be allowed to influence "rushing" tactics. Each man should handle a given weight of refuse per shift and no more and no incentive should be offered to stimulate an energy which may defeat the primary purpose of the Destructor.

Although, as already observed, labour cost is but *one* factor among many, yet it is of interest to review actual costs now obtaining. The various figures here quoted while being of great interest are of necessity somewhat at variance inasmuch as, although in every case they apply to bare labour cost only, yet the conditions obtaining are in some instances antagonistic to low labour cost, while in other cases the conditions are eminently favourable thereto.

The analyses quoted are, however, of general interest and they will serve to explode some few fallacies. Further, such figures not being those quoted by Destructor makers will have the effect of clearly placing before the student of the subject reliable data.

This statement is not intended to cast any reflection upon the figures quoted by Destructor makers, but it should be borne in mind that such figures as a general rule refer to tests only and not to extended periods of working under normal conditions.

Generally speaking tests are conducted under more or less artificial conditions and therefore a labour cost demonstrated during a short test may be very misleading, it is for this reason that in the compilation of the labour costs here quoted test figures, (unless confirmed by actual working experience) have been omitted.

Taking Destructor installations and grouping the same as follows we get the undermentioned averages—

(a) Top Fed Systems. (6 Makes.)

The average of 85 installations gives a labour cost of 13.54 pence per ton.

(b) Direct or mechanical charging systems. (4 Makes.)

The average of 9 installations gives a labour cost of 14.83 pence per ton.

(*c*) Shovel or Hand Fed type (2 Makes)

The average of 25 installations gives a labour cost of 1s per ton, 17 installations *Front* Shovel or Hand Fed type, give an average labour cost of 10.88 pence per ton and 8 installations of the *Back* Shovel or Hand Fed type give an average labour cost of 14¾ pence per ton

(*d*) London and District (6 Makes)

The average of 12 installations gives a labour cost of 16.01 pence per ton

(*e*) Installations with which the power is fully utilized

The average labour cost at 44 such works is 13.07 pence per ton

(*f*) Installations of old types and others where the power is not fully utilized

The average labour cost at 68 such works is 13.10 pence per ton

It is but fair to state that in a few instances the labour cost is abnormal, owing to the quantity of refuse to be destroyed being in excess of the weight which could be dealt with in one shift, but still insufficient to keep the staff fully employed for two shifts

At Padiham, where the labour cost is given as 2*s* 10*d* per ton, this is the case, as also at Aldershot, where the whole of the refuse is destroyed in one and a-half shifts = 18 hours daily, but wages have to be paid for the two shifts (24 hours) The labour cost at Aldershot being 1*s* 1*d* per ton, it will be clear that the labour cost is 25 per cent more than it should be

To put the case another way, if sufficient refuse were available at Aldershot, 25 per cent extra weight could be burned for the same wages cost daily, and this would have the effect of reducing the labour cost to 9.75*d* per ton

The following table of labour cost has been compiled with every possible care, and may be said to represent present *practice*—

ENGLAND AND WALES

	s	*d*
Accrington . . .	1	5
Aldershot . .	1	1
Ashton under Lyne	0	11.60
Manor . .	0	11
„ (2 Makes) . .	0	11
	1	4
. . . .	1	3.50

	s	d
Bath	1	3
Batley	1	6
Beckenham	1	9
Birkenhead	0	10 21
" (2 Makes)	0	10 21
Birmingham	0	9 82
Blackburn	0	10
(3 Makes)	0	11
	0	10 50
Blackpool	1	6 50
Bolton	0	10
Bournemouth	0	9
Bradford	0	9
Brighton	1	7
Bristol	0	11 50
Burslem	1	5
Burton on Trent	1	4
(2 Makes)	1	4
Bury	0	10 8
Buxton	0	11
Cambridge	1	3
Canterbury	1	0 986
Cheltenham	0	7 6
Chesterfield	0	7 6
Colne	0	10 50
Darwen	1	0
Dewsbury	1	1 75
Gloucester	0	10
Grays	0	10
Handsworth	0	10 7[illegible]
Hartlepool	0	11
Hastings	1	0 7
Heckmondwike	1	0
Hereford	0	9
Huddersfield	0	10 50
Hull	1	3
Hunstanton	1	0
Hyde	1	2
Lancaster	1	4
Leeds	0	10 2
(2 Makes)	0	10 2
Leicester	0	8 25
Leyton	1	[illegible]
Liverpool	0	8 2
Llandudno	1	3 [illegible]
Longton	0	11
" (2 Makes)	0	11

(c) Shovel or Hand Fed type (2 Makes.)

The average of 25 installations gives a labour cost of 1s per ton; 17 installations *Front Shovel or Hand Fed type*, give an average labour cost of 10.88 pence per ton and 8 installations of the *Back Shovel or Hand Fed type* give an average labour cost of 14¾ pence per ton.

(d) London and District (6 Makes.)

The average of 12 installations gives a labour cost of 16.01 pence per ton.

(e) Installations with which the power is fully utilized.

The average labour cost at 44 such works is 13.07 pence per ton.

(f) Installations of old types and others where the power is not fully utilized.

The average labour cost at 68 such works is 13.10 pence per ton.

It is but fair to state that in a few instances the labour cost is abnormal owing to the quantity of refuse to be destroyed being in excess of the weight which could be dealt with in one shift but still insufficient to keep the staff fully employed for two shifts.

At Padiham where the labour cost is given as 2s 10d per ton this is the case as also at Aldershot, where the whole of the refuse is destroyed in one and a-half shifts = 18 hours daily, but wages have to be paid for the two shifts (24 hours). The labour cost at Aldershot being 1s 1d per ton, it will be clear that the labour cost is 25 per cent more than it should be.

To put the case another way if sufficient refuse were available at Aldershot 25 per cent extra weight could be burned for the same wages cost daily and this would have the effect of reducing the labour cost to 9.75d per ton.

The following table of labour cost has been compiled with every possible care and may be said to represent present practice.

ENGLAND AND WALES

	s	d
Accrington	1	5
Aldershot	1	1
Ashton-under-Lyne	0	11.66
Aston Manor	0	11
" " (2 Makes)	0	11
Bangor	1	4
Barry	1	3.50

	s.	d.
Bath	1	3
Batley	1	6
Beckenham	1	9
Birkenhead	0	10 21
" (2 Makes)	0	10 21
Birmingham	0	9 82
Blackburn	0	10
" (3 Makes)	0	11
"	0	10 50
Blackpool	1	6 50
Bolton	0	10
Bournemouth	0	9
Bradford	0	9
Brighton	1	7
Bristol	0	11 50
Burslem	1	5
Burton on Trent	1	4
" " (2 Makes)	1	4
Bury	0	10 8
Buxton	0	11
Cambridge	1	3
Canterbury	1	0 080
Cheltenham	0	7 0
Chesterfield	0	7 6
Colne	0	10 50
Darwen	1	0
Dewsbury	1	1 75
Gloucester	0	10
Grays	0	10
Handsworth	0	10 75
Hartlepool	0	11
Hastings	1	6 75
Heckmondwike	1	0
Hereford	0	9
Huddersfield	0	10 50
Hull	1	3
Hunstanton	1	0
Hyde	1	2
Lancaster	1	4
Leeds	0	10 25
" (2 Makes)	0	10 25
Leicester	0	8 25
Leyton	1	7
Liverpool	0	8 25
Llandudno	1	3 25
Longton	0	11
" (2 Makes)	0	11

	s	d
Loughborough	1	2
Lowestoft	0	11 50
Lytham	0	8
Mexborough	0	11
Morecambe	1	0 12
Moss Side	0	8
Nelson	1	0
Newcastle	0	8 16
(2 Makes)	0	8 16
Newmarket	0	11
Oldham	0	9 75
Padiham	2	10
Preston	1	0 12
Radcliffe	0	10
Rochdale	0	7 50
Rhondda	2	7
Rhyl	1	4
Rotherham	1	0 50
Royton	0	9 50
St Annes	1	4 1
St Helens	1	2
Salisbury	1	3
Sheerness	1	0
Sheffield	0	11 50
Shipley	0	10 50
Southampton	1	2 50
Southport	1	2
Stafford	1	4
Stockton on Tees	0	9
Stretford	1	4
Torquay	0	9 50
Wallasey	0	11
Walker on Tyne	0	6 75
Warrington	1	1 75
West Hartlepool	0	10 50
Wimbledon	1	8
Winchester	0	10
, (2 Makes)	0	10
Withington	0	8

SCOTLAND AND IRELAND

	s	d
Edinburgh	2	5 50
Gourock	0	10
Govan	1	0
Paisley	0	9 50
Partick	1	7 1

	s	*d*
Belfast	0	9
Dublin	0	9 9
Dublin	0	11 75
Pembroke	0	11 75

METROPOLITAN BOROUGHS (LONDON)

Battersea	2	0
Bermondsey	1	0
Rotherhithe	1	0
Finsbury	0	8 6
Fulham	1	6 88
Hackney	1	7 1
Poplar	1	10 50
St Pancras	1	1 75
Shoreditch	2	3 3
Stepney	1	4 9
Wandsworth	0	7 50
Westminster	0	11 5

With labour costs varying from 6¾*d* to 2*s* 10*d* per ton it will be obvious that in order to determine the comparative value of the two systems one must carefully investigate all the circumstances of each case At the same time it is clear that the difference of 2*s* 2¼*d* per ton cannot be wholly accounted for by reason of enforced idleness consequent upon the shortage of refuse

The averages already quoted will serve to clearly demonstrate that there is a wide difference between the labour cost with various systems and perhaps nothing is more startling than the high labour cost with systems of top feeding and mechanical charging Close students of the subject have long been aware that top feeding and mechanical charging are not the most economical systems in vogue The figures here quoted should convince even the most sceptical

	s	d
Loughborough	1	2
Lowestoft	0	11 50
Lytham	0	8
Mexborough	0	11
Morecambe	1	0 12
Moss Side	0	8
Nelson	1	0
Newcastle	0	8 1[illegible]
(2 Makes)	0	8 16
Newmarket	0	11
Oldham	0	9 75
Padiham	2	10
Preston	1	0 12
Radcliffe	0	10
Rochdale	0	7 50
Rhondda	2	7
Rhyl	1	4
Rotherham	1	0 50
Royton	0	9 50
St Annes	1	4 1
St Helens	1	2
Salisbury	1	3
Sheerness	1	0
Sheffield	0	11 50
Shipley	0	10 50
Southampton	1	2 50
Southport	1	2
Stafford	1	4
Stockton-on Tees	0	9
Stretford	1	4
Torquay	0	9 50
Wallasey	0	11
Walker-on Tyne	0	6 75
Warrington	1	1 75
West Hartlepool	0	10 50
Wimbledon	1	8
Winchester	0	10
„ (2 Makes)	0	10
Withington	0	8

SCOTLAND AND IRELAND

Edinburgh	2	5 50
Gourock	0	10
Govan	1	0
Paisley	0	9 50
Partick	1	7 1

LABOUR COST

	s	d
Belfast	0	9
Dublin	0	9 9
Dublin	0	11 75
Pembroke	0	11 75

METROPOLITAN BOROUGHS (LONDON)

Battersea	2	0
Bermondsey	1	0
Rotherhith	1	0
Finsbury	0	8 6
Fulham	1	6 88
Hackney	1	7 1
Poplar	1	10 50
St Pancras	1	1 75
Shoreditch	2	3 3
Stepney	1	4 9
Wandsworth	0	7 50
Westminster	0	11 5

With labour costs varying from 6¾d to 2s 10d per ton it will be obvious that in order to determine the comparative value of the two systems one must carefully investigate all the circumstances of each case At the same time it is clear that the difference of 2s 2¼d per ton cannot be wholly accounted for by reason of enforced idleness consequent upon the shortage of refuse

The averages already quoted will serve to clearly demonstrate that there is a wide difference between the labour cost with various systems and perhaps nothing is more startling than the high labour cost with systems of top feeding and mechanical charging Close students of the subject have long been aware that top feeding and mechanical charging are not the most economical systems in vogue The figures here quoted should convince even the most sceptical

Chapter VII

CLINKERING

THE clinkering of a furnace, or the removal of the residuum after destroying a charge is perhaps the most laborious work in connection with the operation of the Refuse Destructor, therefore any practical means of rendering this work less arduous would be welcome, as tending to at once reduce the labour cost and make the work as a whole more pleasant

So far as the actual removal of the clinker from the cell is concerned this is essentially work which can only be satisfactorily performed by manual labour If a charge of refuse is thoroughly burned through and reduced to a satisfactory vitreous clinker, some considerable effort is demanded in order to break up the mass into slabs of such size as may readily be manipulated and drawn through the clinkering doors

With the best of modern Destructors the clinker is withdrawn in large slabs, either direct into a barrow or into travelling skips or buckets slung from an overhead rail, and in most cases it is then freely slaked with water before being taken to the clinker heap This is done firstly for the comfort of the men, and secondly to so cool the clinker that flaming may be avoided when the material is tipped on to the heap

In some few cases shoots and conveyors have been provided for the automatic removal of the clinker, but such an arrangement although very desirable is not practicable In order to thus remove clinker from a modern high temperature cell, it would be necessary to first break the material up into comparatively small pieces This would not only materially add to the already

arduous labour but it would have to be done in the cell, occupying some considerable time retarding the work as a whole, and involving a very serious cooling down of the cell

The clinkering process in the case of the single or isolated cell system especially demands smartness It is essential that the clinker should be removed with all possible speed and although various innovations have been tried nothing has yet been devised which can compete with a live man The simple method already described and which is extensively employed, while being admittedly arduous is best suited to the vital requirements for expeditious and satisfactory working

Counterbalanced clinkering doors easily lifting upwards vertically are the most satisfactory and are appreciated by the men rather than balanced doors swinging outwards These doors do not fit so tightly as the former and when raised for access to the fire the radiant heat from the door baffles is a source of great discomfort to the men Again the vertically lifting door not only projects its heat on the inner side away from the man but it is also so arranged that it acts as a shield, and need only be lifted to a sufficient height for easy manipulation of the clinker

The balanced doors opening outwards at an angle must be practically fully opened to give reasonable access to the cell, and the man is accordingly not only exposed to the heat proceeding from the cell but also to that projected from the inner side of the door

Reasonable attention to such details as these all tend toward minimizing discomfort and it will be obvious that not only does the work proceed more expeditiously when the men are thus considered but it is also more satisfactorily performed under the more comfortable conditions

While successful mechanical means have been devised for both charging and drawing retorts in gas works it must not be forgotten that in the drawing of these retorts the material to be removed is practically [illegible] and has not to be broken up from the walls [illegible] as is the case with the Destructor

While the actual removal of clinker from the building does not offer any considerable scope for labour saving as already pointed out the preliminary withdrawal of clinker from the cell as now performed by manual labour is capable of improvement.

Among the various methods which have been tried and abandoned is the tipping grate which was designed with a view to tipping the clinker direct into a trolley placed in the ashpit immediately under the grate.

The difficulty which was experienced with this arrangement was entirely owing to the formation of the clinker in a vitreous mass over the whole grate area and it was accordingly found necessary to break up the mass before it could be tipped into the trolley beneath.

This breaking up of the clinker to such sizes as would readily pass through the available opening involved considerable labour and it was found as the result of practical experiments that as less breakage was required to withdraw the clinker from a fixed grate into a barrow the process was not only more expeditious but not so laborious.

It is almost safe to say that the present system of withdrawing clinker is not likely to be improved upon it is an operation which demands careful attention and such attention as can doubtless be best given by an experienced man.

When the mass of clinker is broken up it should be turned over so that the small loose material on top may be left on the grate to readily ignite the succeeding fresh charge Further reasonable care must be exercised in the handling of the clinker tools or the brickwork may suffer damage.

The necessity for breaking up the mass of clinker within the cell presents the real difficulty which operates against the saving of labour Every scheme devised for minimizing labour cost at the clinkering stage has failed and largely because of this initial difficulty.

It will thus be clear that apparatus designed for the easy removal of clinker when it is outside of the cell simply means an increase of labour before the material leaves the cell and thus at once any possible economy is seriously discounted.

Up to the present time there is every indication that the system of removal now in vogue is not likely to be improved upon, although it must be admitted that an improvement would be welcome

Chapter VIII

THE RESIDUUM AND METHODS OF DISPOSAL

COINCIDENT with the development of the Refuse Destructor, remarkable strides have been made in the utilization of the residuum familiarly known as clinker

It has been suggested that the difficulties involved in the disposal of clinker are frequently of such a character as to limit the adoption of Destructors It may, however be doubted whether those responsible for such statements are really familiar with the character of good clinker, as also with the variety of purposes for which the same is now used

Clinker varies very considerably, the quality of the clinker is governed by several factors, which we will briefly review

Firstly —High temperature working is essential, unless the cell temperature be high and well maintained, it is impossible to produce a good clinker With the old system of low temperature working a good vitreous clinker was unknown, generally speaking the clinker was soft, worthless, and even at times objectionable Residuum of this character has been to no small extent responsible for the slow progress hitherto made in the utilization of clinker

Secondly —The material within the cell must be exposed to a high temperature for a sufficient length of time, this period of time is an important factor All organic matter should be destroyed, and analysis should show not only a freedom from organic matter, but likewise no combustible Such clinker should be well fused and vitreous, its value will not then be disputed

Thirdly The method or system of charging the refuse into the cells and the thickness of the material upon the grates exercises a considerable influence upon the quality of the clinker Top charging usually means a very much thicker fire than shovel feeding and in the case of the former unless the refuse is very carefully levelled and spread over the grate a thoroughly well burned clinker is not secured

Generally speaking the very best clinker is obtained from shovel fed Destructors of the front and back fed types and this may be largely attributed to the very moderate thickness of the fires and the fact that the whole manipulation of the fires is under more direct control An uneven fire of such thickness as is frequently found with top fed Destructors does not favour the production of the best quality clinker

With top fed Destructors especially of the older types it is common to find refuse on the grates to a thickness of three feet and very unevenly spread The stoker cannot possibly look over the top of the mass and accordingly he is unable to control the condition of the fires a bare or thinly covered portion of the grate at the back cannot be seen and therefore well covered grates are more the result of accident than judgment

With fires of such thickness there is a constant liability of producing inferior clinker After the clinker is removed if the mass is broken it will at times be found that although well fused both above and beneath the inside of the mass is more or less soft and sometimes very offensive

It should not be forgotten that not only is a poor clinker a source of loss in so far as it it worthless and unsaleable but it is at the same time very conclusive evidence that the cremation as a process is unsatisfactory this being due either to the inefficiency of the Destructor or lack of supervision or may be a combination of both

In some few cases not only are communities saddled with a loss due to the unsaleable condition of the clinker, but in addition to this it is not uncommon to find sums varying from 4*d* to 2s 6*d* per ton being paid for removal of the clinker It has been suggested in some such cases that peculiar local circum

stances do not favour the sale of clinker, or that no scope exists for its utilization As a general rule the real explanation is that the clinker is too soft to be serviceable it is utterly useless and is recognized as such Those who would purchase a good vitreous clinker decline even to accept a soft clinker free of charge and they do wisely

The writer is acquainted with many such cases but I am not aware of a single case where any difficulty whatever is experienced in disposing of a good vitreous clinker and many cases might be cited where a vitreous clinker commands a ready sale at a very remunerative figure even as high as *2s 6d* per ton at the Destructor works

Generally speaking the clinker disposal difficulty only exists under such circumstances as one might reasonably expect to find productive of such difficulty It is just as reasonable to expect to find a market for soft clinker as to expect to destroy refuse without the agency of heat

In issuing specifications for Refuse Destructors within the past two years there has been a tendency to ask contractors to guarantee a fixed percentage of clinker or residue While it is doubtless desirable that the percentage of clinker to come should be known it is manifestly quite impossible for any contractor to know exactly what percentage of residuum will be obtained from refuse which may possibly be destroyed a year or even two years after such a guarantee is given

If the period intervening between the date of the contract and the test was only one week the situation would still be equally absurd No two loads of refuse on any one day may be exactly the same in composition and it should not be forgotten that the percentage of residuum is determined by the composition of the refuse and not by any guarantee To ask for a guaranteed percentage of clinker is to ask for a guess neither he who asks for the guarantee nor he who has to give such a guarantee can know the composition of the refuse and without such knowledge a guarantee is but a farce

It is true that the average throughout the country affords a guide 30 per cent is perhaps a fair average but it is quite

possible to get as much as 37 per cent and this with a clinker free from organic matter and thoroughly fused

The only reasonable guarantee to ask for is one to the effect that the clinker shall be free from organic matter (which can be proved by analysis) and further that it shall be vitreous Having secured a guarantee of this character it is not difficult to find a market for the clinker its utility is becoming more clearly recognized year by year

Some analyses of clinker here given are of interest and are worth comparison

Nelson Destructor Clinker

Analysis made by Mr J Barnes F I C Borough Analyst of Accrington December 20 1900

Organic Matter	Nil
Silica	40.6 per cent
Lime	11.2
Alumina	18.5
Ferric Oxide	22.8
Magnesia Manganese and Alkalies	6.0
	100.00 per cent

Bradford Destructor Clinker

Analyses of two samples made by Mr F W Richardson F I C F C S City Analyst of Bradford March 9 1900 —

	1 Fine	2 Medium
Organic and Volatile Matter	4.12	1.80 per cent
Siliceous Matter	61.08	67.10
Iron and Alumina Oxides	21.50	19.30
Carbonate of Lime	7.80	6.00
Magnesia	Traces	Traces
Moisture	5.50	5.80

Torquay Destructor Clinker and Flue Dust

Analyses by Dr Bernard Dyer of London July 1899 —

	Ground Clinker	Flue Dust	
Moisture Organic Matter and Water of Combination	1.00	6.52	per cent
*Phosphoric Acid	1.06	0.96	
Lime	10.47	8.40	
Oxide of Iron and Alumina	33.[illegible]4	33.34	
Carbonic Acid	4.41	10.38	
Siliceous Matter	49.52	40.40	
	100.00	100.00	
Nitrogen	Practically	None	
*Equal to Ammonia	—	0.21	per cent
Equal to Tribasic Phosphate of Lime	2.31	2.0[illegible]	

It is possible that in a few isolated cases where the circumstances are abnormal it would not be possible to utilize or sell the clinker even if it were of the best quality. Under such conditions the clinker might be tipped on to the land or at sea. In either case it would be a harmless proceeding and very different to tipping refuse. If dumped at sea such material would sink and not come in with the tide and defile beaches as is so frequently the case with refuse.

If tipped on the land it would occupy considerably less space than its original bulk of refuse; it would be quite innocuous inoffensive and harmless, and with all due respect to many worthy councillors it may be observed that they would display greater wisdom if they advocated the filling of disused gravel pits, hollows and excavated land with clinker rather than with refuse.

Bacteria Beds

The utilization of clinker in the formation of bacteria beds for the filtration of sewage offers a scope of the highest utility and one that is ever increasing. Perhaps nothing is more in

teresting in modern sanitary science than the utilization of the harmless residuum from one class of civic waste for the purification of the other class of civic waste—the sewage

With this a high utilitarian standard is reached and in this connection it is interesting to remember that in many cases where clinker is so utilized the refuse of which it is the residue has provided power for the operation of the works The value of clinker for bacteria beds is now generally conceded a good vitreous clinker crushed and screened to the sizes required for both the coarse and fine beds furnishes at once not only the most satisfactory medium yet discovered but likewise the most durable medium

Coke and coke breeze which have been employed in the past have to be purchased both are costly and at times disintegrate very rapidly Clinker on the other hand is of such a nature that while possessing sufficient porosity to allow free passage of the liquid it yet deteriorates very slowly indeed

With one or two exceptions wherever clinker has been used for bacteria beds it has given every satisfaction the only failures having been where poor clinker was used the experience while being an unfortunate one emphasizes the need for a vitreous clinker

Enormous quantities of screened crushed clinker and even rough clinker are now taken by contractors and in many cases very remunerative prices are being obtained At Tooting Destructor (Metropolitan Borough of Wandsworth) rough clinker straight from the cells is used freely at 1*s* 9*d* per cubic yard on the works At Dalmarnock Glasgow the whole of the clinker is crushed and screened being eagerly purchased at the works by contractors at 2*s* 6*d* per ton

These are but two examples many others might be cited All the statistics available go to clearly show that enormous quantities of clinker are sold and apparently the disposal of a really satisfactory clinker presents no difficulty whatever

Mortar Making

It is not many years ago since the idea of utilizing Destructor

clinker for mortar making was ridiculed, indeed it was regarded as an experiment and nothing more What do we find now? Over one hundred mortar mills in operation every day at Destructor works alone Mortar sells freely and in every case yields a profit in fact at many works one is told that they wish it were possible to make twice as much mortar

As with mortar making, so with other methods of clinker utilization To look closely into the matter is to be convinced that the utilization of clinker is but yet in its infancy It is impossible to forecast the future developments in clinker utilization

Failure has been freely predicted with every new feature of utilization up to the present, as with concrete and mortar, so with paving flags and bricks but progress is nevertheless recorded and steadily but surely silences all criticism

Paving Flags—It is true that some few municipal engineers are still doubtful as to the value and wearing properties of clinker flags In a few cases this may be attributed to an unfortunate experience with soft clinker Those who are familiar with a really good vitreous clinker have no doubt as to its value for the purpose in question

Others hesitate because clinker flags have not yet been employed under varying conditions for a sufficiently long period to satisfy them as to the wearing properties But nevertheless remarkable progress is being made and, so far as one is able to judge, this means of utilization is likely to find much favour

Flag plants are now in use at Liverpool, Bootle Birmingham, Leicester, Sheffield, Bristol, Bradford, Cheltenham, Blackburn, Withington Oldham, Ealing, Walthamstow, Woolwich and Fulham

In Liverpool, even as long since as 1898, paving flags were being made at a cost of 1*s* 7*d* per square yard including all costs and charges, and it is reported that the flags wear exceedingly well, and have an excellent appearance

Fig 31 illustrates a three mould hydraulic flag press made by Messrs Fielding and Platt Limited, and embodying several ingenious features, not the least of which is the Patent

Vacuum Lift for transferring the finished flag from the press to the carrying board avoiding the necessity of handling and thus leaving the edges of the flag perfectly square

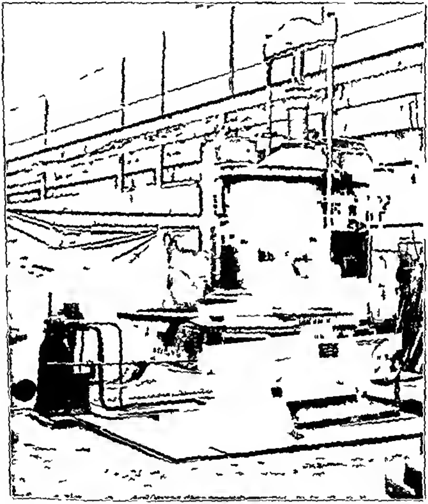

FIG 31 FIELDING & PLATT'S THREE MOULD HYDRAULIC FLAG PRESS

In connection with the manufacture of clinker paving flags the question has frequently arisen as to the period of time which should be allowed for induration between the time of manufacture and laying of the flags

clinker for mortar making was ridiculed indeed it was regarded as an experiment and nothing more What do we find now? Over one hundred mortar mills in operation every day at Destructor works alone Mortar sells freely and in every case yields a profit in fact at many works one is told that they wish it were possible to make twice as much mortar

As with mortar making so with other methods of clinker utilization To look closely into the matter is to be convinced that the utilization of clinker is but yet in its infancy It is impossible to forecast the future developments in clinker utilization

Failure has been freely predicted with every new feature of utilization up to the present as with concrete and mortar so with paving flags and bricks but progress is nevertheless recorded and steadily but surely silences all criticism

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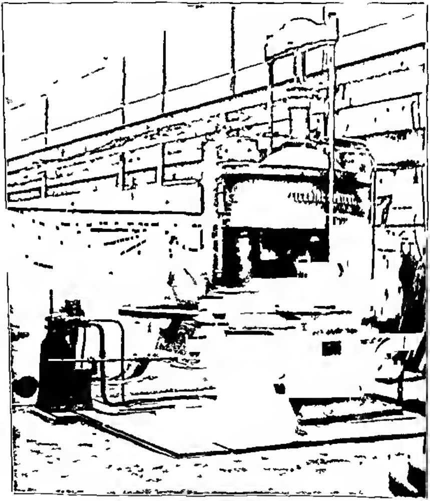

FIG 31 FIELDING & PLATT'S THREE MOULD HYDRAULIC FLAG PRESS

In connection with the manufacture of clinker paving flags, the question has frequently arisen as to the period of time which should be allowed for induration, between the time of manufacture and laying of the flags

The following series of tests were made by Mr. W. G. Kirkaldy, of Messrs D. Kirkaldy and Son, for Mr E. J. Lovegrove, engineer and surveyor of the Hornsey Urban District Council, with a view to ascertaining the gradual increase of strength :—

Results of Experiments to Ascertain the Resistance to Bending Stress of Thirty-two Concrete Paving Slabs.

Load Applied across Centre

Test Number	Description	Span	Dimensions Breadth Depth	Ultimate Stress		Equivalent upon Slab B D 24·00 × 2·00		Appearance of Fracture
		in	inches	lb		lb		
11	Concrete Paving Slab All 30 in × 24 in × 2½ in thick							
1 743	Marked May 28 1900 Age when tested—Two weeks	24·0	24·06 × 2·36	1 505	1 444	1 07[illegible]	1 032	Sound uniform
1 742		24·0	24·06 × 2·39	1 481		1 037		" "
1 740		24·0	24·06 × 2·35	1 400		1 004		" "
1 741		24·0	24·06 × 2·34	1 390		1 008		
1 747	Marked May 21 1900 Age when tested—Three weeks	24·0	24·06 × 2·36	1 626	1 551	1 162	1 094	Sound uniform
1 745		24·0	24·06 × 2·34	1 509		1 104		"
1 744		24·0	24·06 × 2·38	1 511		1 066		
1 746		24·0	24·06 × 2·44	1 555		1 016		"
1 750	Age when tested—Four weeks	24·0	24·09 × 2·40	2 025	1 665	1 102	1 166	Sound uniform
1 749		24·0	24·06 × 2·35	1 548		1 111		Slight defects
1 748		24·0	24·05 × 2·41	1 567		1 075		" "
1 751		24·0	24·05 × 2·38	1 520		1 075		"
1 752	Age when tested—Two months	24·0	24·06 × 2·47	2 596	2 264	1 690	1 543	Sound uniform
1 754		24·0	24·07 × 2·39	2 305		1 622		Slight defects
1 753		24·0	24·02 × 2·42	2 094		1 430		"
1 755		24·0	24·06 × 2·40	2 070		1 430		
1 756	Age when tested—Three months	24·0	24·06 × 2·41	2 223	1 995	1 526	1 367	Sound uniform
1 757		24·0	24·06 × 2·40	2 162		1 497		Slight defects
1 758		24·0	24·06 × 2·41	1 795		1 228		"
1 759		24·0	24·06 × 2·43	1 801		1 219		
1 761	Age when tested—Four months	24·0	24·06 × 2·45	2 780	2 495	1 843	1 730	Sound uniform
1 762		24·0	24·06 × 2·38	2 540		1 786		
1 763		24·0	24·06 × 2·37	2 460		1 747		
1 760		24·0	24·06 × 2·38	2 200		1 546		Slight defects
1 764	Age when tested—Five months	24·0	24·06 × 2·39	3 365	2 849	2 371	1 968	Sound uniform
1 765		24·0	24·06 × 2·42	3 153		2 150		
1 767		24·0	24·06 × 2·42	3 010		2 054		"
1 766		24·0	24·06 × 2·40	1 870		1 296		Irregular
1 769	Age when tested—Six months	24·0	24·07 × 2·34	2 743	2 335	1 997	1 682	Slight defects
1 768		24·0	24·07 × 2·38	2 437		1 709		" "
1 770		24·0	24·07 × 2·36	2 126		1 526		" "
1 771		24·0	24·07 × 2·34	2 035		1 498		" "

The slabs which were used for the above series of tests were manufactured with fine ground Destructor clinker, passing

through a [illegible] inch square mesh sieve and mixed in the proportions of two of ground clinker to one of Portland cement.

The whole of the slabs submitted for testing were made from the same grinding and consignment of cement, the cement being laid out for cooling before use, and passing the standard test of 420 pounds per square inch after immersion in water for seven days.

Excellent results have been obtained in Birmingham, where paving flags have been made since October 1897. During the year 1899, 8,860 square yards were produced; in 1900, 12,106 square yards; and in 1901, 9,852 square yards. The flags, which are chiefly used for footpaths, are 2½ inches thick and faced with granite, the cost of production being 2*s.* 2*d.* per slab, the selling price ranging from 2*s.* 6*d.* to 3*s.* 3*d.*

The following table is of great interest, serving to clearly show the general superiority of clinker as a binding material. The series of tests here tabulated were conducted by Mr. W. Nisbet Blair, M.I.C.E., the Borough Surveyor of St. Pancras.

TESTS OF BRIQUETTES OF CEMENT WITH PIT SAND, RIVER SAND, AND CRUSHED DESTRUCTOR CLINKER

Breaking Strain in Pounds per Square Inch of Section

Proportions	One [illegible]	Three months	One month	Three months	One month	Three months
1 to 1	355	463	335	517	350	560*
1 „ 2	275	36[illegible]	230	312	340	500*
1 „ 3	197	265	250	272	272	230*
1 „ 4	130	28	145	340	267	443
1 „ 5	138	257	143	317	165	375

* In cases thus marked the material was in the form of fine ash.

The interesting diagram (Fig. 32) clearly illustrates the comparative strength of the material employed, and although

it is not contended that the tests are absolutely conclusive, it must be allowed that the clinker briquette comes out exceedingly well and Mr Blair's experiments only serve to confirm many others made in various parts of the country.

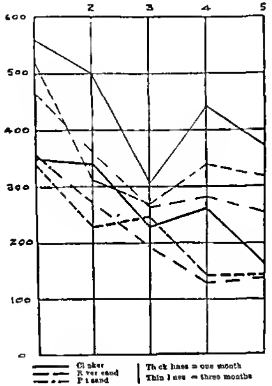

Fig 32

Brick Making

Within the past few months two clinker brick making plants have been installed in London, and although up to the present no really valuable data is available owing to the short period which has elapsed since operations were commenced, it is nevertheless certain that this method of clinker utilization has a very remarkable future

While it is true that very little has yet been done in this country the clinker brick is not an experiment for some few years past several brick making plants have been in operation on the Continent some of which are of British make

Excellent bricks have been made on the Continent even with a clinker of a less vitreous nature than good Destructor clinker In London for some time past quantities of hand made clinker bricks have been manufactured and used the results being so satisfactory that one large contractor has recently erected two large clinker brick making plants after contracting with two Metropolitan Boroughs to take several thousands of tons of clinker per annum for a number of years

To the late Mr John McTaggart of Bradford belongs the credit of first directing attention in this country to the possibilities of the clinker brick Early in 1899 Mr McTaggart made a series of experiments and had he lived it is likely that we should have seen other developments in clinker utilization

The following table of results of Crushing Tests of Bricks made with Bradford Destructor Clinker are of interest as also the figures of tests made with bricks manufactured from Fulham clinker —

BRADFORD TECHNICAL COLLEGE—ENGINEERING DEPARTMENT TESTING LABORATORY

RESULTS OF CRUSHING TESTS OF BRICKS RECEIVED FROM JOHN MCTAGGART ASSOC M INST M E DESTRUCTOR DEPARTMENT BRADFORD

Date	Description	Original Dimensions				Ultimate Crushing Stress				Remarks
						First Crack		Completely Crushed		
		Length in inches	Breadth in inches	Thickness in inches	Area in sq ft	Total Tons	Tons per sq ft	Total Tons	Tons per sq ft	
1899 Oct 27	Ordinary Pressed Brick Sample No 1	9 0	4 4	3 1	275	30 31	112	0 76	184 0	Age unknown
	Sample No 2	8 9	4 25	3 1	262	—	—	53 16	202 9	
	Destructor Clinker and 10 per cent Portland Cement Sample No 1	9 8	4 7	2 4	32	19 61	61 3	24 64	77 0	Made 10 weeks
	Sample No 2	9 6	4 8	2 4	33	9 80	30 2	24 40	75 1	
„	Destructor Clinker and 15 per cent Portland cement Sample No 1	9 3	4 6	3 1	21	22 91	77 1	28 54	96 0	Made 10 weeks
	Sample No 2	9 3	4 6	3 0	29	11 31	37 7	19 01	63 0	
„	Destructor Clinker and 15 per cent slaked hydraulic lime Sample No 1	9 9	4 7	2 5	32	27 70	80 5	38 11	119 0	Made 14 weeks
	Sample No 2	9 9	4 6	2 6	31	—	—	25 58	82 5	
„	Destructor Clinker and 15 per cent unslaked hydraulic lime	9 6	4 8	2 8	32	32 14	100 4	36 22	113 2	Made 14 weeks
„	Destructor Clinker and 10 per cent slaked hydraulic lime	9 9	4 9	2 9	34	54 14	123 8	75 48	222 0	Made 18 weeks

All bricks were faced both sides with plaster of Paris and bedded perfectly true in the machine before applying pressure

G F CHARNOCK Assoc M Inst C E

Results of Tests of Bricks made from Fulham Clinker

MARK A—Size 9 in by 4¼ in by 2⅝ in weight when dry, 6 lb 10½ oz weight after immersion five days 7 lb 5 oz increase 10½ oz percentage 10 composition hardened clinker 90 per cent, hydraulic lime 10 per cent character rough face similar size stock brick, 5 lb 5 oz

MARK B Size 9⅛ in by 4¼ in by 2¾ in weight when dry, 8 lb 12½ oz weight after immersion five days 9 lb 4½ oz increase, 8 oz percentage 6 composition—clinker 85 per cent, cement, 15 per cent character smooth face similar size stock brick, 4 lb 7 oz

MARK C—Size 9¼ in by 4¼ in by 2¾ in, weight when dry, 8 lb 15½ oz weight after immersion five days 9 lb 9¾ oz increase, 10¼ oz, percentage 7¼ composition—not hardened clinker, 90 per cent, lime, 10 per cent character smooth face similar size stock brick 6 lb 8 oz

Note—A fair sample of brick should not absorb ⅙th of its weight—*i e* 16 6 per cent Crushing strain on clinker concrete bricks age 10 weeks equals 113 4 tons per square foot, made at Wandsworth, ditto stock 84 27 tons per square foot, 10 000 yards of flags will take up about 600 tons clinker 30 000 bricks 75 tons clinker, and 600 yards of mortar, 300 tons clinker total 975 tons Equals 30 days supply

Although no actual figures are yet available, it is estimated that bricks made with a mixture of 90 per cent of clinker and 10 per cent of cement, can be produced at a cost of 15*s* per thousand If instead of cement, lime be used, the estimated cost is given as 13*s* 6*d* per thousand Bricks of the former composition would be dried naturally, while in the case of the latter it is preferable to employ the steam drying system, generally known as the Autoclave

The installations in London are being watched with much interest, and they will afford a most useful object lesson If the clinker brick can be produced as satisfactorily and cheaply as is predicted, it is quite certain that this means of utilization will be largely adopted, at any rate by the more important municipalities

CLINKER COTTAGES

While the Liverpool authorities have not been at all troubled

in the past with any accumulation of clinker, the latest method of utilization suggested by the City Engineer, Mr. John A. Brodie, M I C E, opens up a new outlet, and the experiment is sure to be watched with great interest.

Mr Brodie's proposal, which has received the sanction of the

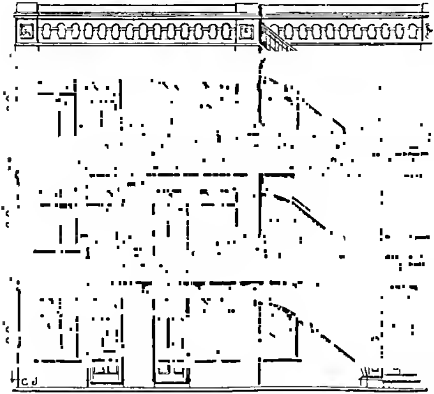

FIG 33 LIVERPOOL CLINKER COTTAGES
Elevation

Housing Committee, is to erect a block of concrete cottages or tenements, the material for construction being crushed clinker from the Destructor and Portland cement, with a small proportion of embedded steel or iron

The crushed clinker and cement will be mixed in proper proportions at the Destructor works, and filled into moulds to

form slabs, each slab representing a complete side, floor or [illegible] of a room.

The openings for doors, windows, fireplaces and flues will be formed in the slabs, and projections in the nature of [illegible] with their corresponding recesses are provided, so that [illegible] of the slabs may be [illegible] to each of the slabs with which it comes into contact when erected, the permanent jointing material being cement mortar.

The [illegible] balustrades and the chimneys where they rise above the roof are similarly moulded in blocks. The site of the building will be excavated where necessary and the foundations composed of the same materials filled *in situ*, brought up to a level surface at the ground level and allowed to set.

When the various slabs and blocks have matured, they are lifted on to wagons behind a traction engine and removed to the site of the proposed building. They are then lifted from the wagons by an overhead travelling crane and deposited in their final position in the building. When the building has been erected the windows, doors, grates and fittings are set in position and completed as usual.

It is anticipated that the income will be sufficient to pay five per cent. on the capital expenditure, as many portions of the work are entirely novel, a very reasonable margin has been allowed for contingencies.

The approximate estimate of the cost of the scheme is as follows:

	£	s	d
Land			
[illegible] per square yard	247	10	0
[illegible]	1 230	0	0
	£1 477	10	0
[illegible]	124	10	0
[illegible] per annum	49	18	4
	£74	17	8

Fig. 33 [illegible] Fig. 34 [illegible] plan of the clinker cottage

at Eldon Street, Liverpool Mr Brodie is to be commended for his audacity and foresight in thus being able to provide the

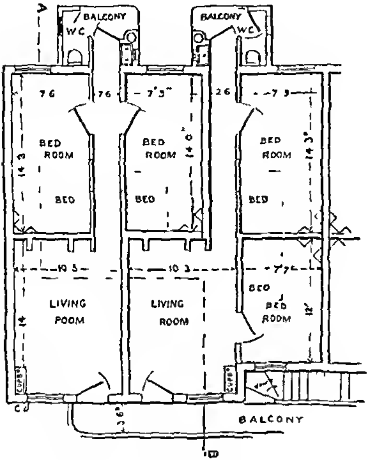

Fig 34 Liverpool Clinker Cottages
Plan

labourer with a really ornate and substantial home at a modest rental

Chapter IX

REFUSE DESTRUCTORS COMBINED WITH ELECTRICITY WORKS

MUCH has been said both for and against the combination and extreme views have been advanced on both sides Those who have constantly asserted that the combination is worthless have in the course of time found themselves faced with actual statistics from various towns clearly proving the combination to be of value and so the critics have gradually decreased in number and the situation to day as compared with that of five years ago has entirely changed

It is a common delusion that the many extravagant statements which have been made concerning the generation of electricity from refuse have all emanated from the Destructor maker On the other hand while some Destructor makers have promised impossible results it must not be forgotten that the maker of the Destructor is always viewed with more or less suspicion whereas the statements of a municipal engineer such as "The Golden Dustman" and of a scientist such as Professor Forbes carry greater weight and obtain more credence

'The Golden Dustman' was a great enthusiast, and an excellent municipal engineer He had a record of splendid service It is no exaggeration to say that he made more money out of refuse than has ever been made either by a municipal engineer or a scavenging contractor before or since

What "The Golden Dustman" said about refuse disposal and power production was believed, so, with the Cantor Lectures of Professor Forbes great interest was aroused and both men were

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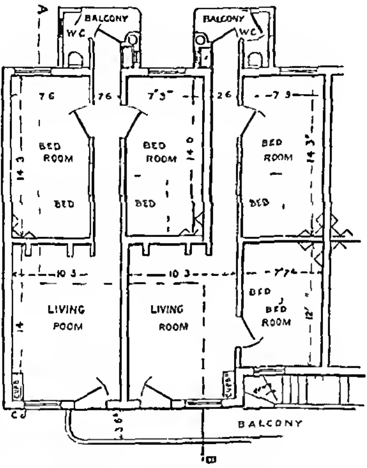

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taken too seriously Professor Forbes has been severely criticized but the substance of his statements was in the main quite correct so far as power production is concerned

It may however be truly said that the Destructors in use some fourteen years since when Professor Forbes delivered his Cantor Lectures were quite unsuitable for producing the power which we were told could be produced but even as remarkable strides have been made during the past fourteen years in electrical engineering so have remarkable developments been made in the perfecting of the Refuse Destructor firstly for its primary object—the destruction of refuse—and secondly as a power producer

The Destructor of fourteen years since was not capable of performing its primary duty that of destruction but in many cases a single multitubular boiler had been included with a battery of cells and although the refuse was not destroyed yet the gases passing through the main flue to the chimney were intercepted and sufficient steam was readily generated to operate a mortar mill or to do other similarly modest work on the Destructor premises

It may be fairly argued that at this time greater wisdom would have been shown had every effort been directed towards perfecting the Destructor as a destructor before thinking of even operating the modest mortar mill

This must be admitted by every sanitarian while every engineer will recognize the absurdity of passing gases through a boiler when the maximum temperature of such gases rarely exceeded 800° Fahr while often falling even below 600° Fahr

To place the modern Destructor on such a level either as regards its primary duty or its suitability or value for purposes of power production is to show either prejudice or ignorance and a failure to grasp the importance of modern developments

It is only necessary to observe here that there are but very few points in common between the early and modern Destructors Instead of imperfect destruction and constant liability to nuisance we have a perfect immunity from nuisance and absolute cremation Instead of a temperature of 800° Fahr as the maximum

temperature of the gases entering the boiler, we now have a temperature varying from 1,600° Fahr to well over 2,000° Fahr

It is no exaggeration to state that the temperature of the gases at the chimney base with a modern Destructor is frequently but little lower than the main flue temperature with the early Destructors In the former case the temperature has been reduced to the extent of from 1,200° Fahr to 900° Fahr owing to the transmission of heat for useful purposes, whereas in the latter case high temperature at any point was unknown

Although many station engineers are still antagonistic to the combination there can be no doubt that as time goes on and records of successful work over extended periods are available, opposition will gradually cease The station engineer is to be commended for being cautious, but much of the opposition still met with is not prompted by caution In some cases there is a great reluctance on the part of station engineers to admit the value of the Destructor in combination because they consider that it would be an unpleasant adjunct

Others, while objecting to take supreme control of a combined works yet strongly resent divided control and in one or two cases where divided control has been introduced, friction has been constant

Professor Kennedy once gave it as his opinion that the man who is held responsible for the utilization of the steam should control its production, and whether the line of argument be appreciated or not it must be allowed that it is reasonable The position of the station engineer must be unenviable when he is relying upon a supply of steam from another department beyond his control, especially if the necessity of steady pressure is not seriously appreciated at the source of supply

If the engineer in charge of a combined works be adequately remunerated, his objections to supreme control would not be so frequently heard The station engineer controls the burning of the coal nor would it be urged for one moment that this department should be separately controlled, while still holding the engineer responsible for steady running and the minimum fuel cost per unit generated

If refuse be regarded as a fuel why then have separate control of its combustion? If the process be considered unpleasant this may in some instances be attributed to the policy of thrusting a sanitary department upon an electrical engineer having in mind the saving of a Destructor superintendent's wages by so doing

One of the arguments advanced against the combination a few years since was that it is impossible to generate steam at a sufficiently high pressure for electrical purposes It was alleged that a pressure of 60 lb was the highest boiler pressure possible with refuse Some nine years since at Rochdale Mr F W Brookman the Cleansing Superintendent once and for all disposed of this argument by working two large Lancashire boilers up to a pressure of 120 lbs This example was soon followed at the Oldham combined works and in both cases not the slightest trouble was experienced In September 1899 at Darwen a further advance was made the Lancashire boilers provided with the Destructor for a working pressure of 200 lb confirming all expectations and while steam was required at the engines at 160 lb pressure no difficulty was experienced in working the boilers up to the full pressure reducing valves being provided for ensuring a steady delivery of steam to the engines at 160 lb pressure

The successful demonstration at Darwen has had far reaching results and high steam pressures from refuse are now so common that the early critics have long since ceased to trouble

Having disposed of this question it was next said that anything like steady steaming was absolutely impossible with refuse as fuel but here again experience has clearly shown the contrary to be the case It is quite true that some of the steam curves reproduced and illustrated in this volume are not altogether satisfactory, but in studying the same it must be remembered that they are diagrams taken under normal working conditions and that the type of boiler and the design of the plant as a whole have a very material effect not only upon the steam production but also upon the steady maintenance of the working pressure

Steady steam pressure is only possible when suitable boilers

are installed, and the volume of hot gases supplied to the boiler at a constant high temperature, with but the minimum of fluctuation Continuity of high temperature is to a very serious extent governed by the design of the Destructor, but as this feature is fully discussed in another chapter it would be superfluous to enlarge upon the same here

Having a plant designed in the best possible manner for ensuring steady high temperature working, and so steady steaming it is still of vital importance to insist upon methodical working, a regular cycle of operations, this demands careful and intelligent supervision

That steady steaming is practicable is beyond all question, but wishing to avoid bare assertions, it would perhaps be well to quote the opinions of engineers controlling combined works Perhaps two such opinions will suffice

Mr W Sillery, M I E E, of Wrexham Combined Works says—

No difficulty is experienced in keeping steam pressure constant, both for traction and lighting, the steam is easily controlled

Mr W B Maxwell, Partick Combined Works—

We have no difficulty whatever in maintaining a steady pressure without the use of coal except on Sundays or holidays, or when there is insufficient refuse to meet the demand for electricity [1]

In designing a combined plant it is undoubtedly advisable to arrange for a reasonable margin between the boiler pressure and the pressure of steam required at the engines As already pointed out at Darwen there is a margin of 40 lb, the boiler pressure being 200 lb and the engine pressure 160 lb, this margin is most helpful allowing as it does for a reasonable fluctuation in the steam pressure at the boiler, which will happen at times however carefully the work is supervised Such a margin, while involving no difficulty if first-class reducing valves are used, ensures steady steam pressure at the engines

Some electrical engineers, while not questioning the value of the Destructor as a power producer, have expressed doubts as to

[1] See *The Electrician* December 12, 1902

the thoroughness of the combustion It has been said—Is the combustion perfect? Are you not sacrificing the primary object of the Destructor in endeavouring to satisfactorily realize the secondary? In reply to such questions it may be fairly said that with the well designed modern Destructor the combustion is far more perfect than is the case with the average steam boiler fired with the best coal

This question is exhaustively dealt with in another chapter, and it will be clearly seen that the efficiency of the combustion process as shown by analysis reaches a standard which is approached by very few coal fired steam plants in this country The principles governing perfect combustion have certainly received very much closer attention in connection with the design of the best modern Destructors, than is the case with boiler furnaces generally speaking

The high temperature reached, the reasonable margin of fluctuation in temperature, the high percentage of CO_2 in the gases of combustion, all afford conclusive evidence of excellent practice in efficient combustion and those who carefully study this important phase of the subject cannot fail to be impressed with the very satisfactory conditions existing

COMPARATIVE STATEMENT SHOWING THE NUMBER OF ELECTRICAL UNITS GENERATED PER TON OF REFUSE DESTROYED AT TWENTY COMBINED ELECTRICITY AND DESTRUCTOR WORKS

Town	Make of Destructor	Type of Destructor	Type of Boiler	Average Number of Units Generated per Ton of Refuse Destroyed	Average Weight of Refuse Destroyed Daily in Tons
Accrington	Horsfall	Top Fed	Lancashire	25	60
Bangor	Meldrum		Hornsby	20	9
Cleckheaton	,,	Hand	Lancashire	35	12
Colne	,,	Top	Babcock	20	18
*Darwen	,,	Hand	Lancashire	33	35
*Fulham	Horsfall	Top	Babcock	20 62	100
Gloucester	Heenan	Back ,,	,,	35	25
Grays	Meldrum	Hand ,,	Lancashire	33	8
Liverpool	Manlove	B & B	Babcock	29 5	97
Llandudno	Meldrum	Top Fed		32	15
Nelson	,,	Hand ,,	Lancashire	40	30
† Partick	Manlove		Babcock	27	42
Rhyl	,,	,,	,,	15	16
St Helens	Meldrum	,, ,,	,,	37 3	32
Shipley	,,	Hand	Lancashire	37 8	25
Shoreditch	Manlove	B & B	Babcock	20	80
Stepney	,,	Top Fed	,,	32	165
Warrington	Meldrum	,,	,,	80	50
Wimbledon	,,	,,	,,	45	54
Wrexham		Hand	Lancashire	38	35

* Average for 1 year † Average for 3 months ‡ Average for 1 month § Two thirds refuse, one third sludge

In the case of a small town, under the best conditions it is obvious that the maximum benefit in the way of power production is secured from the Destructor in the first few months' working of the station, because, while the demand for current is ever increasing, the quantity of refuse available, while increasing slightly in a growing town, cannot possibly increase in the same ratio as the demand for current

It should be borne in mind that in the case of combined works using electrically driven fans for providing forced draught, and also electric hoists or elevators the electrical output per ton of refuse destroyed is *inclusive of* the current actually used in connection with the operation of the Destructor

To take two examples At St Helens for the year 1900–1 the average number of units used on the works per ton of refuse destroyed is given as 7 1 At Shoreditch the average for one year gives nearly 5 units per ton of refuse destroyed as used for works purposes

It will thus be apparent that in order to arrive at the actual number of useful units available per ton of refuse destroyed it is necessary to deduct such current as is used for works purposes and this must be done in order to enable fair comparison to be made with the results obtained where the fans are steam driven or steam jet blowers are used

At a combined works where steam jet blowers or steam driven fans are used the electrical output per ton of refuse destroyed is a *net* useful quantity and the proportion of steam used for purposes apart from the actual generation of electricity represents so much *extra* power produced per ton of refuse destroyed

In a few towns no coal whatever has been used for the first six months' working, in one or two towns refuse has supplied all the steam required for the first year, but in every town sooner or later it becomes necessary to use coal, and while the weight of coal consumed is gradually increasing, the quantity of refuse available practically remains stationary

Although this is so very obvious that it would seem almost unnecessary to admit it, we constantly hear that the combination is of doubtful value because refuse will not supply the necessary power for all time It is further said that combined plants are only suitable for small towns Perhaps the most conclusive reply to such a statement is to cite such a case as Liverpool, where power is being produced for traction purposes every day from some 300 tons of refuse Other large towns might be mentioned, while still others such as Preston, Burnley, Notting-

ham and Wolverhampton all tend to show that there is a considerable difference of opinion

When large towns such as Wolverhampton Nottingham and Preston decide to erect Destructors to deal with such quantities as 80 tons of refuse daily and supply power for electrical purposes it must be admitted that the small town argument falls rather flat the more so when it is borne in mind that at two out of these three towns Corporation electricity works equipped with a number of coal fired boilers had been in operation for some years before the installation of the Destructor was decided upon

Cases such as these tend to considerably strengthen the case for combination and most conclusively show that as the result of careful investigation it has been considered worth while to produce electricity from refuse

Although there is a very considerable variation in the electrical output per ton of refuse destroyed at the combined works included in the table of comparative results it must not be forgotten that different conditions obtain in almost every case In some instances the load factor is high in others very low The Destructors differ in design and method of charging the boilers differ in type while some are set as close as possible to the cells others are a considerable distance from the cells With some installations hot air is used for combustion and economizers are provided in other cases neither of these useful accessories are included

Again in some stations the refuse is all destroyed during that period approximating to the period of lighting or power demand while in other cases a proportion of the hot gases go to waste through the bye pass flue the Destructor working steadily throughout the whole twenty four hours

It is but fair to point out that in such cases it may happen that the refuse burned does not get full credit in the number of units generated per ton of refuse destroyed because while the steam may only be used for eighteen hours during the remaining six hours the refuse is being destroyed practically at the same rate and the total number of units generated during the day is divided by the total number of tons burned

As already observed the attitude of the station engineer has changed and by not a few the combination is now regarded with favour

As I write this chapter I have before me letters from sixteen station engineers expressing favourable opinions concerning the combination It is impossible to quote all these opinions, we will therefore make a brief selection

The electrical engineers at the undermentioned towns express themselves as follows—

CLECKHEATON

So far we have every reason to be satisfied with the results I consider that our combination is most efficient

WREXHAM

The combination in our case is most useful and no difficulty is experienced in keeping steam constant for both traction and lighting

ACCRINGTON

The combination is useful in connection with a small works which has a day load

BECKENHAM

A combined electric light station and Destructor is undoubtedly useful when a day load is obtainable

ASHTON UNDER LYNE

The Destructor now contributes heat equal to what would be produced by several hundred tons of coal

LINCOLN

Mr Stanley Clegg (late of Darwen)

From my own experience I know that a Destructor and electricity works can work together for their mutual advantage It would certainly be impossible to raise the steam pressure to normal working pressure after a fall due to cleaning out, as quickly by any other firing process [1]

[1] See *The Electrician* p 608 January 30 1903

While some engineers of combined works have [illegible] to make concerning the presence of dust in the engine room, there certainly have been instances where trouble has arisen through dust reaching the engine room, but this is no real argument against the combination; it merely indicates what has for a long time been obvious to many, i.e. that great care is demanded in the general planning out of the whole scheme. The arrangement and design of the buildings calls for special attention. The Destructor boilers, while being as close as is practicable to the engine room, must, as part of the Destructor, be isolated from the engine room.

The arrangements for the deposit of clinker should be such that its dust is not blown about. The destructor house should be ventilated, preferably by a well devised system of downward exhaust, and if this be done, the atmosphere will not only be more congenial for those employed in the Destructor building, but dust will be prevented from escaping therefrom.

Lastly, but not least in this connection, when the refuse is delivered, the carts (which should be covered) should disappear within closed doors. If these matters receive careful attention when the plant is being designed, there is no excuse for any dust trouble either inside or outside.

Some critics of the combination have put themselves to some considerable trouble in endeavouring to show that refuse has a varying calorific value, and that it is accordingly very unreliable as a fuel.

Little can be gained by producing an array of figures, in order to refute that which is not disputed. It is generally admitted that the calorific value of refuse varies to a considerable extent, but as the result of considerable experience, the average value is now known, and as a general rule this average forms the basis of a [illegible]

[illegible] King's Norton, [illegible]num, being anxious to ascertain the calorific value of the refuse, arranged for the sampling of loads as collected on specified dates, the several samples being sent to an analyst,

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with the remarkable result that the calorific value of the refuse was shown to be about 4,500 B T U

The analysis of one pound of refuse gave the following result—

Carbon	36 8	per cent
Hydrogen	29	" "
Nitrogen	29	" "
Sulphur	19	" "
Oxygen	7 3	" "
Ash	41 7	" "
Moisture	12 12	" "

It is not contended that the average refuse has a calorific value of 4 500 B T U this particular sample was obviously a very good one The average calorific value of refuse as a fuel may be safely put at 3 000 B T U Many actual steam raising results in various parts of the country clearly demonstrate this

The many tests recorded herein will serve to show that after allowing for all the unavoidable losses, in the cells combustion chamber flues and boilers, the calorific value of the refuse must necessarily have been as high as is claimed for the average refuse

It should not be forgotten by those who suggest that the Destructor can never be a satisfactory power producer because of the varying calorific value of refuse that coal also varies considerably in calorific value

The varying calorific value of refuse being fully appreciated is not the troublesome factor which some would have us believe The Destructor is not designed simply for dealing with homogeneous material, on the other hand it is capable of dealing with every class of waste Such is indeed expected, and can be readily dealt with

On the other hand, when *variable coal* is delivered to any public works or generating station, unless the steam boilers are equipped for dealing with a variety of fuels, which is not an easy matter, considerable trouble is experienced

Again and again when action has been taken by local authorities against electricity works or manufacturers for permitting black smoke to escape from their chimneys, the excuse has been

that fuel such as usually employed could not be obtained or that Welsh coal was not procurable or maybe the coal merchant is blamed for delivering inferior fuel

It is now almost impossible even in London to purchase fuel on analysis that is to contract for a supply of expensive fuel of a known calorific value which value shall be guaranteed The explanation simply is that even expensive fuels are to some extent unreliable and the vendor knowing this declines to take the risk

Is it not unreasonable to expect a standard calorific value from refuse when such cannot be relied upon from expensive coal? It is beyond all question that the varying calorific value of refuse never gives anything like the same trouble as that experienced from the occasional delivery of inferior coal

Other critics of the combination pronounce it useless because the Refuse Destructor falls short of their own standard of general efficiency It is considered by such critics that because every ton of refuse the whole year through cannot be relied upon to evaporate the same weight of water therefore the Destructor is useless

As my friend Mr Frank Broadbent M I E E recently pointed out in the columns of *The Electrical Review* during a controversy over The Fuel Value of Refuse the Refuse Destructor is scathingly condemned by some because it falls short of such a standard as is not even expected from the steam boiler fired with coal the high class steam engine or the dynamo

The Refuse Destructor is tested over considerably longer periods than the coal fired boiler the engine or the dynamo but while a few hours run is considered quite satisfactory for these, even a test of one month continuously is not considered satisfactory for the Destructor

Evaporative tests are here recorded covering periods of from a few hours up to one month Some tests have been carried out in the summer months others during the winter and under a great variety of conditions If these tests are carefully studied it will be observed that even with varying rates of combustion as

in the case of Nelson the efficiency is well maintained Further it may be fairly submitted that if coal were burned under such varying conditions the fuel efficiency would vary to a far greater extent On the highest rates of combustion the fuel efficiency of coal would be seriously reduced while with refuse the efficiency is scarcely affected

Up to the present time combined works are either in operation or have been definitely decided upon in over sixty towns comprising in the aggregate 370 Destructor cells and 140 high pressure steam boilers the total destroying capacity being over 3 200 tons of refuse per day

In the London district alone nearly 800 tons of refuse is being destroyed daily the resultant power being used for generating electricity and yet in spite of such a remarkable record of progress the utility of the combination is still questioned by not a few engineers

The above figures will probably be startling even to those in charge of combined works and others intimate with the subject Such figures cannot be seriously quoted as merely showing a resolve for foolish emulation It is idle to submit that scheme after scheme has been decided upon without investigation and satisfaction and furthermore it should not be forgotten that every scheme has to be approved by the Local Government Board who not only give close attention to the technical details but also devote some considerable attention to the economic aspect

An amusing case came under the writer s notice some few months since in a town near London where a municipal electricity works had been in operation for about three years with a heavy net deficit each year

It was decided to erect a Destructor at the adjoining sewage works utilizing the power from some 30 tons of refuse daily to pump the sewage and by so doing to save a coal bill of nearly £1 000 per annum The scheme was no sooner decided upon than the Electricity Committee began to exert themselves with a view to securing the Destructor for combination with the electricity works but they were too late and much to their chagrin they

were reminded that the combination which they were at length so anxious to bring about had been previously considered by them and wisely or unwisely abandoned as useless

When it is borne in mind that nothing short of actual results in power production could popularize what will always be regarded by some as an unsatisfactory combination it must be admitted that with sixty combined works either in progress or in course of erection wonderful strides have been made It would be idle to suggest that this remarkable progress is but a passing craze, that all these schemes have been initiated blindly, or as the result of what has been termed that strange fascination for producing light from dust '

On the other hand it must be admitted that these combined schemes have only been decided upon after searching investigation indeed it is no exaggeration to say that this combination is perhaps even now more closely investigated than any other contemplated municipal enterprise

Progress has been made not because of a mere desire for emulation but as the result of close scrutiny It is true that the sanitary aspect is ever a weighty factor but in itself this presents no conclusive argument for the combination the determining factor is whether the combination is a desirable one from the point of view of economy

That the combined electricity and Destructor works has come to stay there can be no doubt and with the development of electric traction we shall undoubtedly see many more combined works erected in the near future

The record of combined works up to date is a very satisfactory one and when it is remembered that as recently as five years since only two such works were in operation there is every reason to feel satisfied with the progress made

To those who still doubt the value of the combination the writer would say—investigate personally inquire closely into every aspect of the question If you are a layman you will find such investigation of more than passing interest If you are an electrical engineer I still say investigate even if you have had personal experience of one combined works and that experience

Secondly.—It is likely to become increasingly evident as Destructors continue to be erected at sewage works that in normal cases the refuse of a community is frequently in excess of what is actually required for pumping the sewage produced. This will not be satisfactory to the economist, for various reasons. If the whole of the refuse is carried to a site on one side of the town at a heavy cost, and one half of the refuse only, is sufficient to save a coal bill of £300 per annum, then the remainder must be simply destroyed and the heat allowed to run to waste, and this after incurring a heavy cartage cost and also the labour cost for destruction. Briefly, the only asset is such satisfaction as may be derived from the knowledge that the sanitary ideal has been reached.

At Hereford and Aldershot, and also some few other places, it has been clearly shown that all the steam power required at the sewage works can readily be supplied with far less refuse than is available. For six years past at Hereford one third of the available refuse has supplied the whole of the steam required for pumping over 1¼ million gallons of sewage every day in 10 hours, also for operating sludge presses and lime mixers, and for the lighting of the works. The 10 tons of refuse is collected within an area as close as possible to the sewage works, to keep down the cost of cartage. In the first 5 years the economy effected at Hereford sufficed to pay every charge in connection with the Destructor up to that time, the installation having cost rather less than £1,200.

To provide small Welsh coal previous to the erection of the Destructor involved an expense of £350 per annum, and not one pound of coal or fuel other than refuse has been provided at the sewage works since the Destructor was started. It will thus be readily seen that had the remaining two-thirds of Hereford refuse been taken to the sewage works, the cartage cost would have been a very serious item, the labour cost would have been nearly trebled, and as the power could not be utilized, the loss involved in destroying the two thirds would all but render a net saving quite impossible.

The reader may say, Why not destroy the balance of two-

thirds at the Electricity Works? But surely it would be a very questionable proceeding to erect two distinct Destructors installations in so small a city

Whenever a Destructor is combined with an electricity works and more particularly in the case of a small town it is essential that the whole of the refuse be destroyed there *Firstly* because as a general rule the whole of the power can be fully utilized, and *secondly*, because it is open to serious doubt whether it would be worth while to incur the necessary capital cost to deal with only a portion of the total refuse produced especially when that portion can only supply a comparatively small amount of power as compared with the total power required

It would be idle to deny that the sewage works load is eminently suitable, generally speaking it is a constant load The pumping may occupy only 10 hours out of the 24 or it may be necessary to pump through the whole period In either case the work is usually very steady

Even if the pumps are only in operation for 8 hours daily, no difficulty is experienced in banking the fires with refuse from day to day and so much heat is conserved in the brickwork that the working steam pressure may be quickly reached from banked fires

Although as already observed the sewage works load is a fairly constant one yet it frequently happens at some combined works that an abnormal flow has to be dealt with in time of storm, at such times the work is exceedingly heavy and although the conditions then obtaining are all against the Destructor yet again and again it has been demonstrated that with intelligent handling it is quite equal to the abnormal demands

At Aldershot during last summer although the normal flow of sewage does not exceed 550 000 gallons daily yet during the torrential rain storms as much as 2 500 000 gallons had to be pumped and this with very wet summer refuse of very low calorific value and with an abnormal percentage of moisture, but in spite of this not one pound of fuel other than refuse was used

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undertaking, commercially speaking It is recognized as a necessity from a sanitary point of view and it is clearly understood that in itself it must have a charge on the rates

In the past there has been a tendency to instal Gas engines at sewage works more particularly in small towns but with the many excellent combined sewage and Destructor works now in operation a gas plant can only be recommended under exceptional circumstances specially favouring this form of motive power

It may be assumed that 5 tons of refuse daily will provide sufficient power to pump the sewage of a population of say from 5 000 to 7 000 and as the clinker is now recognized as a valuable asset at many sewage works for use on bacteria beds even in the case of a small town the Destructor offers distinct advantages as compared with the gas engine

If gas engines be chosen or if a steam plant be installed with coal as the fuel the refuse question has still to be faced and if the bacteriological system of sewage treatment be decided upon without clinker available this must be purchased and often from a considerable distance It is true that coke or coke breeze may be used but these have to be paid for ordinary furnace clinker is sometimes available but neither of these three mediums can be compared with good vitreous clinker and this is now generally admitted

The clinker then is valuable and being produced on the spot is in itself a considerable source of economy To the thoughtful citizen it must be interesting to know how one form of civic waste will in the process of destruction furnish power for dealing with the liquid waste and that the innocuous residue from the former offers the best known medium for the purification of the latter

To the sanitarian this acme of utility must appeal with force It must be admitted that very satisfactory progress has been made but which perhaps can only be fully appreciated by those who have had opportunities of carefully studying the problems involved

In a few towns electrically driven pumps have been installed

at sewage works but little headway has been made This may mainly be attributed to the fact already alluded to viz the location of the sewage works To lay a cable in some cases over a distance of one mile means a serious initial expense after which *transmission losses have to be reckoned with*

In one or two cases electric driving has been substituted for steam driving mainly to provide a day load for the electricity works but with very unsatisfactory results financially to the sewage works

A case of this kind recently came under the writer s notice—a town within 100 miles of London where for many years with a steam plant the coal bill had never exceeded £500 per annum The conversion to electric driving involved a payment of over £1 100 per annum to the electricity department for the supply of current to do practically the same work Incredible as this may seem it is absolutely true and *it represents nothing more or less* than the deliberate crippling of one department in order to support another which should be self supporting

In two towns where both the sewage and electricity works are on the same site good results are being obtained but in both cases it is interesting to note that Destructors are also combined

In the above case it may perhaps be fairly argued that the Sanitary Committee should only pay the Electricity Committee the same sum as was previously paid for coal but rightly or wrongly that sum was increased to the amount quoted

Whatever advantages may accrue from the electrical driving of sewage pumps the fact remains that it cannot be compared with the combination which we are discussing just as the gas engine falls short of the ideal so does electric driving The Refuse Disposal question remains unanswered

A Destructor can often be erected at a sewage works with but little expenditure as compared with an entirely new and complete installation This when fully appreciated must carry great weight

In many cases Destructor cells might readily be adapted to existing coal fired boilers the same chimney would also suffice thus the capital expenditure may be very materially reduced

At Hereford, Nuneaton and Aldershot, among other towns, this course has been adopted, and the Destructor adaptation has been highly successful, fulfilling all expectations at the absolute minimum of cost

Having steam boilers within a building, and a suitable chimney, the Destructor, with a building and accessories only, have to be installed The structural alterations usually necessary are not serious, and involve but little expense

The adaptation of Destructors to existing boilers at the sewage works at Hereford, Aldershot and Nuneaton for example, cost less than £1,200 in each case, the result being the saving of the whole amount previously paid for coal this being as follows—

Hereford	£350 per annum
Aldershot	£300
Nuneaton	£200

In addition to the above saving, the clinker is fully utilized for the bacteria beds and other purposes affording an additional source of economy

In many towns where steam plants are now in use at sewage works, involving a fuel cost of from £500 to £1 000 per annum, Destructors might be adapted and the whole of the present fuel cost saved

To effect such a saving in every case would involve an expenditure varying from say, £1 500 to £3 000 according to the weight of refuse to be dealt with It must be admitted that this presents a very strong argument for the combination, and further that such combination would be of immense benefit to the long suffering ratepayers apart altogether from the realization of the sanitary ideal which must be ever foremost

Chapter XI

REFUSE DESTRUCTORS COMBINED WITH WATER WORKS

ALTHOUGH up to the present time little has been done in the combination of Refuse Destructors with Water Works there is no doubt that during the next few years many such combined installations will be erected

If the Destructor is carefully designed and contained within suitable buildings contamination need not be feared even with open reservoirs in use In such a case however the question of design calls for special attention The buildings must be so arranged that the Destructor plant is entirely closed in air being drawn into the building for ventilation and exhausted by suction for purposes of combustion

The arrangements for storage of refuse as may be necessary should be as perfect as possible The clinker instead of being wheeled out into the open should be stored under cover The refuse must be delivered at the works in closed or covered vans and tipped within the building with preferably closed doors

If no open reservoirs are in use and the deep well pumps are enclosed within a distinct building then the combination of the Destructor does not involve so much expense in the arrangement of the buildings there being practically no risk of contamination if reasonable care be exercised

Some few months since a section of the Council of a town in the Eastern Counties were anxious to destroy the refuse of the town at the water works mainly with a view to saving the coal bill The quantity of refuse available being found inadequate for the purpose the scheme was abandoned

Curiously only a few months before the matter was intro-duced to the Council they had unanimously censured their water works manager for keeping a goat and a few chickens in his garden, as [illegible] contamination of the water was feared and the [illegible] had to quit. Such an incident is only men-tioned to [illegible] some Councils are. If pollution or contamination [illegible] possible owing to the presence of a few chickens and a goat, what might be expected from the filth of a town?

As already [illegible] in order to meet the special require-ments of the [illegible] be found necessary when erecting a Destructor [illegible] to spend rather more money on the buildings [illegible]. It may also happen that the special [illegible] Destructor will involve a slightly greater expenditure [illegible] conditions. Should this be deemed [illegible] upon cheerfully having in mind the [illegible] of the case and the absolute necessity for [illegible].

Sentimental [illegible] been overcome, one of the causes which [illegible] against the combination of Destructors with water works will be the location of many works.

As with [illegible] water works. As a general rule, they are [illegible] positions, in fact in not a few cases water works are [illegible] distance from the town. In such cases the [illegible] the determining factor.

A few years ago [illegible] a Refuse Destructor with a water works would have been [illegible]. I may go further and say that the weight of sentimental objection fol-lowed by the [illegible] of the Local Government Board would have at once rendered the combination impossible. It may at once be admitted that even a few years since the combination was not advisable. The Destructor had not been perfected and, generally speaking, the design was crude and unfinished. Those details in design and general arrangement which are so essential for this combination had not been considered. Under such circumstances the combination of a Refuse Destructor with a

water works would have been productive of trouble, and examples of the kind would have seriously militated against future combination

Happily there are no failures to record, this, perhaps the most critical combination of all, was only entered upon at the right time, i e when the Destructor was perfected, therefore with a clear record and no unfortunate past, this combination must find favour and we shall see many combined works in the immediate future

At Sheerness where a Destructor is erected in combination with the water works the results obtained have been exceedingly satisfactory, with the exception of Sundays, when, of course, there is no collection of refuse No coal whatever is used, the daily collection of refuse providing the whole of the steam required for lifting the town's water supply from the deep wells

Perhaps no more central site could be found than that at Sheerness and fully appreciating the absolute necessity for preventing nuisance of any kind, the building was so arranged that the carts when bringing the refuse in, disappear within closed doors The Destructor end of the building is also so screened off that any escape of dust, either when charging or clinkering the cells is rendered absolutely impossible

In order to clearly appreciate the position of this Destructor it is necessary to refer to Figs 81 and 82 Not only is the Destructor within a few yards of the water works but, within a few feet of the tipping platform, a school is situated, this building will be observed in Fig 82 on the extreme right

In front of the Destructor buildings are the Council offices, while the whole site is surrounded by houses The writer, who advised the Sheerness Urban District Council, was quite convinced that, notwithstanding the abnormal conditions, it would be quite possible to erect a Destructor in this unique position, providing careful attention was given to the details and also to the design of the building

The general arrangement of the building was discussed with the Council's surveyor, Mr T F Berry, and we were able to design a building which, while being in every way suitable,

was at the same time so arranged as to absolutely prevent nuisance of any kind

Few water works in this country are so centrally situated as in the case of Sheerness, and it is safe to say that there is not another Destructor similarly located It may, therefore, be of interest to briefly review the reasons which induced the Sheerness authorities to decide upon the site in question

Faced with a scavenging account of over £20 per week, which amount had to be paid to a contractor for collecting and tipping some 70 tons of refuse weekly, burdened with a coal bill at the water works of £500 per annum, it is not strange that economy was sought The author, after looking carefully into the case strongly advised the Council to erect a Destructor at their water works, because this would effect a twofold economy Firstly the scavenging and collecting cost would be reduced to the minimum, and, *secondly*, the coal bill would be saved

It was clear that by choosing the site in question an economy of at least £900 per annum could be effected It now remained to arrange the plant and the buildings to meet the peculiar necessities of the case, as already observed This was done, and as I write this, the first six months' working just completed shows an economy at the rate of nearly £1,000 per annum equal to a reduction of 3*d* in the pound on the rate

The unique interest attaching to such a case as Sheerness is my excuse for dealing with same at such length The experience gained with such an installation is of the utmost value even apart altogether from the particular combination in question. A Destructor working under such abnormal conditions is a most useful object lesson and should do much to popularize the Refuse Destructor and instil confidence

Chapter XII

DESTRUCTOR SITES

THE real *vexata questio* now generally speaking is not whether a Destructor shall be adopted or otherwise but rather as to where it shall be located

There is a prevalent and mischievous delusion that for the most part Refuse Destructors have been erected at a considerable distance from houses This is absolutely incorrect On the other hand no less than 94 per cent of the Refuse Destructors working at present in Great Britain are in close proximity to houses

Naturally the question of site is one of great importance in connection with the Power Destructor Electricity works are invariably erected on central sites sewage works and water works are also as a general rule situated within reasonable distance of the centre of a town In a large number of towns it is therefore possible with a reasonable cartage cost to destroy the refuse on such a site as offers an outlet for the profitable utilization of the resultant heat for steam generation

It is very remarkable that those who would have the Destructor erected beyond the limits where the power can be utilized are the same people who would raise no objection to the filthy accumulation of refuse on a tip in a very much more central position They aggravate their incongruity by insisting upon a considerably heavier cartage cost for sanitary and final disposal than would satisfy them in connexion with the primitive and filthy method of hoarding filth It is ignorance of this type which we have to combat and the task would be very much more

difficult than it is if it were not for the very reasonable attitude of the Local Government Board

There could perhaps be no more striking tribute to the general excellence of the modern Destructor than the fact that the Local Government Board are constantly sanctioning schemes where it is proposed to erect Destructors in very central positions

It cannot be urged that the Local Government Board have any self interest and it must be conceded that each case is carefully investigated publicly on the spot and afterwards considered on its merits

If any sympathy has been shown by the Local Government Board towards schemes providing for the fullest utilization of the power which course is clearly for the benefit of the ratepayers such sympathy or interest is always dominated by the main factor which must always be the suitability of the proposed plant for the specific conditions existing

Every Destructor scheme does not pass the Local Government Board without modification and suggestions are frequently made either by the Inspector when examining the site or at a later date when the evidence and plans are under consideration at Whitehall

Local Government Board inquiries concerning Refuse Destructors are by no means devoid of humour Perhaps I may be permitted to enliven the dull pages of a work of this character with one reminiscence In a town near London which shall be nameless an inquiry was being held and many witnesses gave evidence against the proposed site although it was by no means centrally situated One worthy member of the Urban District Council—who by the way had never seen a Destructor—addressed the Inspector for some few minutes with much vehemence but with little logic The Inspector who was visibly wearying at length asked the witness whether he would be so good before proceeding further as to enlighten him (the Inspector) whether he was speaking *for* or *against* the proposed Destructor Needless to add the worthy councillor quickly resumed his seat

The question of a suitable site is such a vexed one to the lay

mind that few Local Government Board inquiries concerning Refuse Destructors pass without opposition Having given evidence at a number of inquiries the author is in a position to say that the opposition as a general rule is of a frivolous and ignorant nature The proposal to introduce a Destructor is resisted frequently by a number of well meaning but nevertheless ignorant citizens

The experience gained by the Local Government Board Inspector is such that he is readily enabled to sift evidence and appraise the same at its real value If this fact were only recognized by some energetic citizens who will talk about that which they have never seen and do not understand the result would be a great saving of time and money

Among the illustrations here reproduced a few will be found showing Destructors erected in somewhat unique positions These are however but a few out of many such installations As already observed the majority of the Destructors in this country are in daily operation in close proximity to houses

That complaints of any kind are almost unknown should be an all sufficient answer to those who doubt and it should be borne in mind that a considerable percentage of the Destructors which have been erected in close proximity to houses were erected many years ago and accordingly are not so well designed or so complete as modern Destructors

Much has been said about depreciation in the value of property as the possible result of the erection of a Destructor near to houses but this may at once be dismissed as untrue Again and again has the author heard this aspect argued at Local Government Board inquiries on some occasions by eloquent counsel on other occasions by the trembling property owner but never yet have I heard any logical evidence whatever in support of such an assertion nor have I ever heard a single example quoted to show that property does depreciate

On the other hand I have heard a mass of evidence to the contrary and I have heard cases cited where property has increased in value this of course not being due to the erection of the Destructor but merely owing to local circumstances Such

cases do, however, clearly support the case for the Destructor Granted that a Destructor can be erected upon a central site, and operated without nuisance, such a site should be chosen, if for no other reason, then for the common good of the ratepayers

In every town of reasonable size the cost of collection of the refuse is a factor worthy of very careful consideration, and every effort should be made to bring down the cost of collection to the minimum

The minimum of cartage cost, combined with the fullest possible utilization of the power, offers at once the maximum of advantage to the ratepayer If he is so ill-advised as to resist this, in the result his own pocket is touched

Chapter XIII

THE COMPARATIVE ADVANTAGES OF STEAM JET BLOWERS AND FANS

THE comparative advantages of steam jet blowers and fans for use in connection with Destructors presents a highly controversial subject Much has been written in defence of each, but in spite of this the question is still a vexed one, and there is every indication that it will so remain

Destructor makers who employ fans lose no opportunity of asserting the superiority of the Fan over the steam jet blowers, while the makers of the latter avow that steam blast possesses distinct advantages over dry air blast

It must be admitted at the outset that in so far as actual steam consumption is concerned, the fan usually has the advantage, and this is perhaps the main advantage claimed for the same by its advocates

Another advantage which is realized in some combined electricity and Destructor works is that it is possible to operate an electrically driven fan earlier after standing while steam jet blowers could not be used until a reasonable steam pressure had been reached in the boiler

It should not be forgotten however that in most combined works, although the Destructor may be standing with banked fires for many hours, the steam pressure in the boiler is usually sufficiently high to enable steam jet blowers to be supplied and operated immediately

As the result of considerable study, the writer has come to the conclusion that the economic advantage already mentioned is,

generally speaking, the only real advantage possessed by the fan over the steam jet blower

Allowing that the fan is more economical in steam consumption, the steam jet blower still has distinct economic advantages over the former These may be briefly summarized as follows—

(*a*) That the first cost is considerably less

(*b*) That the cost of upkeep and maintenance is but trifling

(*c*) That it is exceedingly simple, and self contained, the steam consumption being in direct proportion to the work done

That the steam jet blower equipment is very much cheaper will not be disputed, as also the fact that the cost of upkeep and maintenance is negligible, whereas it is not only necessary to provide fans in *duplicate,* but the depreciation is serious, attention and lubrication are also essential

The advantage of the steam jet blower from the point of view of simplicity is so obvious that it may be passed over Again if a fan is provided to supply draught to, say, six cells the fan must still be used, even if only two cells are in use, and the steam consumption is not *pro rata* with the reduced work Further depreciation must still be allowed for, and the fan demands perhaps as much attention as though working up to the maximum

On the other hand, with the steam jet blower, if only one cell out of six is in use, the steam consumption is in direct proportion to the work done With a four grate unit Meldrum Destructor, for instance, if only two grates (only half of the cell) are in use, the blowers under those two sections of the grate only are in use

It has been recently suggested that with the steam jet blower, moisture may be deposited upon the back end of the boiler and economizer pipes This suggestion is without any foundation in fact, hundreds of cases might be cited where steam jet blower draught has been in use for over ten years past, and moisture has not been detected upon the end plates of boilers or upon the economizer pipes On the other hand, wherever this system of forced draught is installed, the efficiency of the

economizer is materially increased, resulting of course, from the higher combustion temperature [1]

In a paper read in Dublin early in March of the present year, Mr H Norman Leask, the writer of the article already mentioned again referred to the alleged deposit of moisture and advocated the use of dry hot air as against saturated heated air [2]

That dry hot air is of immense value for combustion there can be no doubt but what is meant by saturated heated air is not at all clear unless a combined system of steam jet and fan is intended as shown in Fig 35

This illustration shows Heenan's Patent No 9,065 of 1900, and provides for the employment of a steam jet in connection with a fan preferably to utilize exhaust steam It is said that—

This method of heating the forced draught or air supply utilizes the

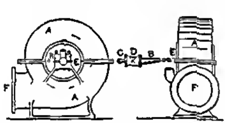

FIG 35 HEENAN'S PATENT COMBINED CENTRIFUGAL FAN AND EXHAUST STEAM JET

heat of the exhaust steam which would otherwise be lost and at the same time effects a considerable advantage in the combustion of the furnace

Now if as Mr Leask submits, a deposit of moisture and ultimate corrosion may result from the use of live steam, often at 150 and even 200 lbs pressure, with steam jet blowers, then it is but reasonable to suppose that this trouble must be very much more serious if exhaust steam is used

Again if exhaust steam will materially add to the temperature of combustion it must be conceded that high pressure steam

[1] See *Surveyor* January 30 1903

[2] See *Proceedings of The Institution of Civil Engineers of Ireland* 1903

should greatly increase the temperature, and for the saturation of heated air it is quite certain that exhaust steam must be very much more effective than live steam even of low pressure

It is, perhaps, only natural that the advocates of fan draught are not content with the candid admission that in actual steam consumption they have the advantage because, as will be seen, there are other vital considerations apart altogether from the actual consumption of steam necessary to move a given volume of air

With further reference to the question of moisture it is interesting to note that even in some large modern Destructor installations provided with fan draught,[1] provision is made for turning on a supply of live steam previous to clinkering thus at once admitting the value of free steam

Mr H Norman Leask in the paper already referred to, argues that a higher temperature can be obtained with fan draught, but this is entirely contrary to actual experience

The highest temperatures and the highest average temperatures on record have all been obtained with steam jet blower draught, together with an altogether remarkably successful record

This is not a question of one maker against another but of the comparative merits of two entirely different systems of air supply

Mr W H Maxwell, Chief Engineer of Partick electricity and Destructor works where a high class fan draught plant is installed, and also steam jet blowers, expressed his opinion as to the comparative value of the two systems, as follows—[2]

> The relative advantages of fan and steam blast is a point of great importance I have made no tests but from actual working we have found that with the latter a steadier steam pressure is maintained, and more steam per ton of refuse is available at the engines

The Partick installation is a modern one, being opened in March 1902 Three centrifugal fans are provided, each capable of delivering 10,000 cubic feet of air per minute, each fan being

[1] This is now a common practice with Fan Draught.

[2] *The Electrician* December 5 1902

driven by an independent single cylinder high speed engine Two fans are capable of supplying all the air required, the third fan standing idle in case of a breakdown

Mr Maxwell's opinion obviously cannot be lightly passed over It is clearly expressed, and substantiates what has been claimed for the steam jet blower

Nearly three fourths of the modern high temperature Destructors in this country are provided with steam jet blower forced draught, moreover, in a few instances fans have been removed and replaced by steam jet blowers, and in connection with several Destructors where complete fan plants are installed, steam jet blowers are also fitted

It may be reasonably asked, why steam jet blowers are installed in addition to a duplicate installation of fans? It may further be observed, why is the former installed under any circumstances if it is so inefficient as we are told?

We may assume that steam jet blowers are included in addition to fans in duplicate because, although duplicated, it is still possible for the fans to break down As to the alleged inefficiency of the former, this must be judged by the reader, who has facts and figures before him directly bearing upon both systems

The steam jet blower was once defined as "a cast iron pipe, having a steam pipe at the inlet end" The writer fears that this is a definition which might be given by many critics but the fact remains that such a definition fails entirely to convey an accurate description of a good steam jet blower

It may be truly said that even as there are fans and *fans*, so are there blowers and *blowers* That a remarkable difference exists in the efficiency of various fans is well known Even if not generally known it is none the less true that there is a very wide difference in the efficiency of steam jet blowers

The problem which the maker of steam jet blower apparatus is confronted with may be briefly stated as "how to move the greatest volume of air with the smallest volume of steam," and correct scientific proportion and design enter largely into the production of the first class steam jet blower The close student

of the subject will be aware that steam jet blowers differ in efficiency to perhaps a greater extent than fans Blowers are in use in connection with Destructors using from 12 per cent to 40 per cent of the total steam produced

Whilst it is of the highest importance especially with the modern power Destructor that the draught should be produced for the lowest possible steam consumption yet as will be evident there are other considerations of great importance

Some of these we have already discussed there now remains the question of water gas in combustion Generally speaking our British refuse is sufficiently rich in carbon to produce and maintain a temperature sufficiently high to decompose the steam the result being the formation of water gas in the cell

The water gas is formed during the passage of the steam through the bed of incandescent fuel on the grate The underside of the clinker when removed differs essentially from that removed from a cell worked with fan draught In the former case the underside of the clinker has a clean and vitreous appearance leaving the grate surface with comparative ease the result being that the clinkering process is less arduous and the fire bars have a much longer life

With fan draught unless supplementary steam is used the labour involved in clinkering is materially increased and the fire bars suffer by the adhesion of the clinker and so need more requent renewal

The water gas far from having a deterrent effect on combustion as has been alleged is of very great benefit More or less plausible theories have been advanced with a view to explaining away the value of water gas but as against theory there is accumulated evidence of fact Mr George Watson has clearly demonstrated its value and has done not a little to put on record comparative results which all go to prove that the formation of water gas is of material advantage It would appear that the effective chemical combination of certain gases is more definitely ensured with vapour present than with dry air

Some years since when Lord Kelvin and Professor Barr conducted exhaustive experiments at Oldham Destructor works

they were deeply impressed with the utility of steam jet blower draught as the following extract from their report will show

> The steam is condensed by contact with the cold air which it injects and the water thus produced is re evaporated in contact with the furnace bars keeping down their temperature In this way the life of the furnace bars is greatly prolonged A more important function is however fulfilled by the steam In coming into contact with incandescent fuel it is decomposed the hydrogen being freed while the oxygen combines with the carbon in the fuel to form carbon monoxide
>
> This decomposition of the water is effected by heat abstracted from the lower part of the fire where it can be of comparatively small valu for the cremation of the distillate
>
> The Water Gas (Hydrogen and Carbon Monoxide) passes upwards to be burned by the excess air which it meets with over the fire thus serving to increase the temperature which would otherwise exist at tl e meeting of the products of combustion with the gases distilled from the raw material

The formation of water gas has always been regarded as one of the advantages of the steam jet blower and as being peculiar to this type of draught but a glance at Fig 35 and a perusal of the extract from the patent specification will show that the use of an exhaust steam jet with a centrifugal fan must inevitably have the effect of producing water gas To quote from the specification we are told that

> It effects a considerable advantage in the combustion of the furnace

The only advantage accruing must obviously be due to the presence of moisture—the formation of water gas and it is indeed remarkable that this combination of an exhaust steam jet and a centrifugal fan was patented by one of the severest critics of the steam jet blower, which on the other hand is always designed to use live steam, and that usually at high pressures

Such figures as are available all go to show that the combustion is more perfect where steam jet blowers are in use Care has been taken to include authentic figures only, and the analyses here quoted may be accepted as correct

As is well known the nearer the air supply is kept to the quantity theoretically required for combustion the higher is the percentage of CO_2 (carbonic oxide) The test for CO_2 is now

generally accepted as being the standard test for determining the efficiency of combustion

As it is useful in comparing results obtained with the two systems of draught production to know the air pressure in the ashpits (in inches of water) and also the rate of combustion these figures are included in each case (see Tables pp 152 153)

The comparative figures in the following tabular statement are worth careful study they very clearly show that for perfect combustion the Destructor working with steam jet blower draught has the advantage It is only possible to take into consideration such figures as are complete and authentic It is true that the tests are but few in number but they cover long as well as short periods forced and easy working and air pressures from $1\frac{1}{8}''$ to 3 1" Further four distinct types of Destructors are represented and on the whole it may be submitted that fair comparison can be made

It will be observed that some tests for CO were made at Warrington in 1894 these were probably the first tests of the kind ever conducted in connection with Destructors The analysis of the gases of combustion is a comparatively new departure in connexion with the Destructor practice Such analyses were never heard of in connection with the old low temperature Destructors and in the light of modern practice it is easy to see what imperfections such analyses would have laid bare

Concerning the excellent percentage of CO_2 in every case with steam jet blower draught perhaps the Rochdale results are especially noteworthy these very high figures being obtained *with all the doors open eight inches* This but serves to prove what has been contended for years past by those who have closely studied the matter that it is possible to so regulate the forced draught and chimney pull that a perfect balance of the gases is secured and with this condition existent in the cell cold air cannot enter even with the doors wide open

This may be readily tested in a simple but conclusive manner by holding a handkerchief loosely in front of the open door it will remain perfectly motionless if the gases are balanced by

STEAM JET BLOWER DRAUGHT

Table Showing the Percentage of CO_2 in the Gases of Combustion

Town	Date	Duration Test	Rate of Combustion	Ashpit Pressure	Average % CO_2	Average % CO	Average % Oxygen	Apparatus Used
Oldham	May 1898	24 hours	29 lb	1¼ in	5 samples 8.60 15.50 18.10 8.50 13.30	none	10.90 3.90 1.40 10.[illegible]0 6.30	Orsat
*Rochdale	May 20 1895	95 in ordinary work	50 lb	1¼ in	16.90 17.36 (2 tests)	Nil — —	.96 1.90	Orsat
Lancaster	February 7 1902	12½ hours	59½ lb	1.75 in	16.5	—	—	Orsat
Nelson	February 19 to March 16 1901	1 month 473½ hours	29 lb	1.50 in	13.16	—	—	Orsat
	April 25 1901	8 hours	68½ lb	2¼ in	(30 readings) 14.40	—	—	
	December 20 1900	9¼ hours	57 lb	1.85 in	12.21	—	—	
Hereford	May 4 1898	10 hours	54.98 lb	1.45 in	15.56 14.92	(20 readings) Nil	(20 readings) 5.40	*Econometer*
	5	10½	51.52 lb	1.37 in	16.84 16.83	(16 readings) Nil	(16 readings) 3.54	Orsat
	6	10	54.75 lb	1.82 in	16.27 16.38	(14 readings) Nil	(14 readings) 3.74	

* All doors open 8 inches

TABLE SHOWING PERCENTAGE OF CO_2 IN THE GASES OF COMBUSTION

Town	Date of Test	Duration of Test	Rate of Combustion per Square Foot	Average Ashpit Pressure Inches of Water	Average % of CO_2	% of CO	Average % of Oxygen	Apparatus Used
St Helens	April 10 1900	7 hours 20 min	103 lb	3 1 in	(21 readings) 10 4		(20 readings) 9 16	Orsat
Blackburn	May 15 1901	7 hours 40 min	34 66 lb	—	11 [illegible]			[illegible]
Warrington	June 30 1894	10 hours	[illegible]	2 in	[illegible]	[illegible]	[illegible]	
Metropolitan Borough of Wandsworth	February 1903	120 [illegible]	[illegible]	[illegible]	[illegible]			[illegible]

proper regulation of the forced draught If this balance does not exist, whatever system of forced draught is in use, cold air will enter when the doors are opened, the combustion, i e the percentage of CO_2 will suffer accordingly, and if the simple handkerchief test be applied, this, instead of hanging vertically inactive, will be sucked in the open door immediately

Like the Rochdale figures, the Hereford figures are also of much interest, in this case the percentage of CO_2 being tested by means of the Econometer, as well as the Orsat apparatus An Econometer is still in daily use at Hereford, giving a constant record of CO_2 in the gases Further, at Hereford this remarkably high percentage of CO_2 is obtained notwithstanding the fact that cold air is supplied to the blowers for combustion, while in the case of the latter installations included in the table such as Lancaster and Nelson, hot air was used

Combustion and the Air Supply

There can be no doubt that the more closely the cardinal principles governing combustion are adhered to the better are the results obtained Of course, the whole question of design and proportion is also closely involved and demands careful attention, or it is impossible to obtain satisfactory results

It has already been observed that the modern American Destructor is very unsatisfactory, and that this may be largely attributed to lack of knowledge and experience in design Had Destructors in this country not been designed by those properly qualified, it is quite possible that our position would be but little better than that in America This particular class of work, however, has always been recognized as a distinct branch of engineering, and this to a large extent goes to explain why our failures have been but few, compared with the many failures in America

So long as the qualified and experienced engineer is recognized as being alone fitted for this special work, so long shall we progress Even in more modest furnace work, again and again

it has been shown that the inexperienced will not do and that to engage one who is not a specialist is to court disaster

Combustion in furnaces may be simply expressed as controlled chemical combination of the elements—carbon and hydrogen—in the refuse or fuel with the oxygen of the atmosphere

It may be also well to observe at the outset that unless perfect combustion is obtained it is impossible to operate a Destructor satisfactorily this must be the case whether the Destructor is a Destructor pure and simple or whether the power is utilized

Notwithstanding the absolute necessity for perfect combustion it is a fact that five out of every six Destructor works in this country are without any apparatus for analysing or testing the gases of combustion The composition of the gases is unknown in many instances even where Destructors have been in operation for from ten to twenty years it is safe to say that the gases have never been tested

In spite of this any inquiry as to the possibility of imperfect combustion would only lead to an invitation to look into the cell or main flue perhaps to gaze at the chimney top This may be satisfactory or it may not certainly it cannot be compared with actual analysis a mere glance through an inspection hole or even into an open door can but very inadequately convey what is actually taking place in the way of effective combination of dissimilar elements Again even close scrutiny of the chimney top while satisfying the layman is but a poor index as to what is taking place in the cells

It is of the highest importance that the air supply be so regulated that the excess of air supplied for combustion shall be as low as possible closely conforming to theoretical requirements Where this matter has received careful attention in connection with large steam power installations within recent years a remarkable advance has been made and a point of efficiency has been reached which is almost incredible

When similar methods have been suggested in connection with Destructor installations it has been observed that such a high efficiency is not necessary and that while it is perfectly reason

able to thus ensure the highest economy with coal, which is often costly to purchase, no such methods are worth serious consideration when refuse is being burned, because of its low calorific value

Such a line of argument is not so reasonable as it may at first sight appear If refuse is recognized as possessing a fuel value, it is surely worth while to ensure the yielding up of its maximum calorific power It is a question of inefficient *v* efficient combustion, *firstly* and even as a Destructor pure and simple it is important that the combustion should reach the highest efficiency while at the same time such a condition is essential for the best possible results in power production

It is only by careful attention to the air supply that real efficiency can be attained and the maximum efficiency is of great importance with the modern Destructor in order to render the same self supporting

Owing to the provision of very high and powerful chimneys with the early Destructors the excess of air passing through the cells must in many cases have been enormous With 2 per cent only of CO_2 in the gases of combustion, the loss of heat would be about 65 per cent , owing, of course, to the heat taken up by the excessive volume of air supplied With 9 per cent of CO_2 in the gases the loss in this way would only be 15 per cent, and with 14 5 per cent of CO_2 registered, the loss would be reduced to 10 per cent To show a percentage as high as 14 5 per cent constantly would be excellent practice, but nothing more than should be aimed at and insisted upon as being evidence of efficient combustion

The diagram prepared by the late Mr Bryan Donkin (see Fig 36) serves to clearly show the loss of heat resulting from an excess of air as indicated by the percentage of CO_2 in the gases of combustion

The two methods of analysis for determining the percentage of CO_2 in the combustion gases are, briefly the gravimetric method, with which the percentage is determined by weight, and the volumetric method, giving the percentage by volume The latter system, although demanding chemical knowledge, is more

extensively used and gives very accurate results, the most popular apparatus being that known as the "Orsat."

FIG. 36

The gravimetric method is perhaps best represented by the "Econometer" an instrument which gives a constant reading of the percentage of CO_2 on a dial, and requires but very little attention.

A number of these instruments are in use in various parts of the country, in connection with steam boilers, and when tested with the Orsat apparatus for CO_2, the results practically agree.

THE USE OF HOT AIR FOR COMBUSTION

The employment of heated air for combustion is perhaps one of the most useful departures in recent years in Destructor practice While the real utility of this innovation is more manifest with the power Destructor, than with the Destructor pure and simple there can be no doubt that in the case of the latter it is exceedingly beneficial

The heating of air has been effected by two distinct methods only up to the present, the first being by means of side air boxes, this system being peculiar to the Horsfall type of Destructor, and the regenerative system of air heating, first introduced with the Meldrum Destructor

The two systems are entirely different in principle, the Horsfall air boxes being placed on the sides of the firebars in the cell, firstly to prevent clinker adhering to the brickwork for which purpose they are very effective, secondly to receive the air direct from the blast flue, and distribute the same under the grate

It is obvious that the air, in its passage through the air boxes must have a cooling effect on the metal, in this way facilitating clinkering from the sides and protecting the walls of the cell, but unfortunately although this system has been in use for many years, no records are available as to the temperature to which the air is heated in passing through the air boxes

With Meldrum's Regenerative system the whole volume of hot gases after leaving the boiler, is intercepted and caused to pass vertically downwards through a battery of staggered cast-iron pipes, the cold air for combustion circulates around the outer surface of the regenerator pipes, and is induced by the steam jet blowers to travel through a conduit connecting direct to the ashpits, where it is forced through the fire by the blowers

A somewhat similar system of air heating has been adopted with the "Heenan" Destructor as part of Howden's system of forced draught, which has been employed so extensively with marine boilers

It is well known that hot air has remarkable absorbent properties, and herein lies one great advantage in its use with the

Destructor, it rapidly absorbs moisture, so effective indeed has the regenerative system proved to be in this respect, that the drying hearth has been entirely dispensed with

While the use of hot air not only dispenses with the necessity for a drying hearth with its perpetual distillation process it enables very wet refuse to be readily dealt with without any difficulty and this is very essential with the power Destructor because for instance in the case of a sewage works in time of flood or abnormal rainfall when the pumping work would be much heavier, the refuse also being unduly wet would be less useful as fuel

With wet refuse on the drying hearth and the forcing of the fires to meet the extra demand for steam and cold air only available for combustion the danger is that while the amount of steam required is three times that required for normal pumping under the very unfavourable conditions it may be difficult to obtain even normal evaporation from the boiler

The results obtained with the regenerative system have been in every way satisfactory clearly proving that the combustion is more perfect the temperature higher and more easily maintained These features are perhaps more readily appreciated in connection with a power installation but at the same time it must not be forgotten that such favourable conditions of high temperature working with but little fluctuation ensure perfect cremation a vitreous clinker and an immunity from nuisance

By the rapid absorption of moisture the ignition point is reached so much earlier and thus the whole cell is brought into an active state more quickly than can possibly be the case when hot air is used Further the air supply for combustion with hot air approaches more closely to the quantity theoretically required than is the case with cold air

A few actual figures will doubtless be of interest, as showing the difference in the temperature of air for combustion entering and leaving the regenerator the former temperature may be taken as being approximately the temperature of the atmospheric air in the building at the time of the test, and accordingly represents the temperature at which the air would have been supplied to the cells had the regenerator not been in use

Town	Date	Duration of Test	Average temperature of Air entering Regenerator	Average temperature of Air leaving Regenerator
Darwen	Sept 30 1899	48 hours	62° Fahr	328° Fahr
Nelson	Dec 20 1900	9½ hours	Average of 19 readings 64° Fahr	346° Fahr
Nelson	Feb 19 to March 16 1901	473½ hours continuous		243° Fahr
Nelson	April 25 1901	8 hours	Average of 20 readings 82° Fahr	394° Fahr
Lancaster	Feb 7 1902	12 hours 26 min	62° Fahr	478° Fahr

These figures will serve to clearly show that the air for combustion in its passage through the regenerator chamber is highly heated and as this heat is abstracted from the gases after they have passed the boiler it is so far a net gain as unless an economiser be installed the volume of the heated gases would pass direct from the boiler to the chimney

Experience has clearly shown that a Destructor supplied with hot air usually discharges the gases even from an amply large boiler at a sufficiently high temperature not only to heat the air supply passing through the regenerator chamber but also to efficiently heat the boiler feed water in an economiser

It will thus be seen that not only is the initial or cell temperature considerably higher when hot air is used but the fluctuations in temperature are confined within much narrower limits and lastly the ultimate temperature must obviously be higher The ultimate temperature or the temperature beyond the boiler is a matter of importance because as has been already observed the waste gases are of value for other purposes after actual steam raising

Chapter XIV

SPECIAL POINTS IN DESIGN FOR SECURING AND MAINTAINING HIGH TEMPERATURE AND STEADY STEAMING

In a critical analysis of design and construction it becomes necessary to separate Destructors into at least two distinct groups. *Firstly*, we have single cell systems represented by the "Horsfall," the "Fryer," the "Warner," and the "Baker" patents.

By single cell systems is meant any arrangement of cells either in single row, or back to back in a block, or arranged with a boiler between every two cells. In short, every arrangement of Destructor cells which does not provide for the intermingling of the gases from two or more cells, either in the cell or cells, or in a combustion chamber common to both or all of the cells.

In the second group must be placed all systems embodying in a lesser or greater degree the principle of "mutual assistance." In this group we have Meldrum's system of "continuous grate," and also their Improved Beaman & Deas type, which has always been known as a system of erecting cells "in pairs," with a combustion chamber common to each pair of cells. Heenan's system of "Twin Cells," also having a common combustion chamber for one or two pairs of cells; and lastly the "Sterling" destructor, likewise designed on the "pair" principle and having a central combustion chamber.

Although divided into distinct groups, a great variety in design will be found in each group. It is unnecessary to discuss

the details of design here, the special features of each make being described in another chapter

As already indicated, each group embraces various makes embodying two distinct principles A careful study of the matter has led the author to the conclusion that the principle here defined is to a far greater extent responsible for the varying degrees of efficiency than mere details in design and construction

It has been said that it is impossible to secure a high temperature in the cell this is an erroneous idea—it is quite possible to secure and maintain a high temperature in the cell, but this can only be effected by designing the cell in such a manner that it shall never be idle With systems conforming to this principle the highest degree of mutual assistance is embodied, and theoretically such systems should be the most perfect as Destructors because of the maintenance of a high temperature *in the cell* and most efficient as power producers, because such maintenance of high temperature *in the cell* ensures a constant supply of hot gases to the boiler, the temperature of the gases being high and well maintained

Following on similar lines, the types which next most closely approach the principle of "mutual assistance" are cells erected in pairs but in the case of these there is a distinct difference each cell is idle for clinkering and charging alternately, and it is therefore impossible to maintain a high temperature constantly in either of the cells, but the principle of design and the alternate system of charging and clinkering ensures the maintenance of a high temperature in the combustion chamber which as already pointed out is common to a pair of cells

With all systems of single cells, whether the cells are arranged in single row, back to back, or on either side of a boiler, each cell *as a cell*, is isolated and entirely distinct from its neighbour In the ordinary alternative system of working an idle cell is in turn of necessity next to an active cell, and we may assume that in the case of the former, after clinkering and charging the temperature will be fully 1,000° Fahr below that of its active neighbour

Out of a battery of four such cells three may be in full work while one is being clinkered and charged but the inactive cell can derive no benefit from its active neighbour on either side excepting in so far as the whole volume of gases intermingle in a common main flue *beyond the cells*

Ten years since Sir Alex R Binnie and Dr Shirley F Murphy in their report to the London County Council on Refuse Destructors, expressed their opinion as follows—[1]

> In our opinion any arrangement which makes it possible for the imperfectly heated gases from drying refuse to escape into the flue without being compelled to pass through the hottest part of the furnace is an imperfect one It is true that such gases may be completely burned by subsequent exposure to the heat of a cremator, but the most satisfactory and economical method appears to be to secure the most complete combustion possible *in the cell itself*

The foregoing report, while showing that the value of the front exhaust was fully appreciated, clearly carries with it a further meaning It is suggested that the most complete combustion possible should be secured *in the cell itself* Precisely, and to ensure this it is of the utmost importance to secure and maintain a high temperature *in the cell itself*

Too much importance cannot be attached to the question of complete combustion *in the cell* The safeguards beyond the cell may be ample, and in every way satisfactory, but it is of primary importance that we begin at the beginning If complete combustion be secured in the cell, then it matters not what may, or may not, happen beyond the cell in the main flue combustion chamber, or immediately under the boiler tubes as the case may be That the intermingling of the gases in the main flue may not be entirely satisfactory in maintaining a continuity of high temperature in the case of smaller installations is very obvious to the close student of design and as a very large number of installations in this and other countries must necessarily be but small, the question is one of considerable importance

[1] See *Report on Dust Destructors to the London County Council* dated May 10, 1903 By Sir Alexander Binnie and Dr Shirley F Murphy,

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Out of a battery of four such cells, three may be in full work while one is being clinkered and charged, but the *inactive* cell can derive no benefit from its active neighbour on either side, excepting in so far as the whole volume of gases intermingle in a common main flue *beyond the cells*

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Mr Frank Watson, A M I C E, in a paper read at Dublin in August, 1898, remarked as follows—[1]

> It is found that when a considerable number, *say six cells or more*, are combined in one block, the mixing of the gases from the various furnaces ensures a very steady and very high temperature in the main flue and it is therefore always found advisable to construct the furnaces in blocks in this manner rather than to divide them up and put boilers between them

This would appear to clearly emphasize what has already been said concerning the vital importance of ensuring complete *combustion in the cell itself, whether the installations* be large or small

In thus making close comparison there is no intention to unduly criticize any particular make of Destructor or to direct invidious comparison between any two makes The issue is broader, it is a question of principle and design, a question of suitability for most effectually securing a continuity of high temperature within the cells Mr Frank Watson's statement which I have already quoted is in itself an admission of the weakness referred to

Too much attention cannot be given to the actual work *within the cell*, there the work should be done, and if the cell temperature is well maintained we need not trouble about what may happen beyond the cell Continuity of high temperature is demanded as the working condition of the cell, we may point to a main flue or a combustion chamber, even as many years since we were invited to look at the cremator, to see evidence of heat, when we failed to see such evidence in the cell

It has been said that each single cell—one of a row or block—should not be considered as distinct in itself, but as part of a whole While it is true that each single cell discharges its gases into a main flue common to the whole, yet this is the one and only point of connexion *As a cell*, each cell is distinct, and separate from the cell on its right or left, and it is impossible for one cell, as a cell, to derive any assistance from any other cell in

[1] See Paper read by Mr Frank Watson, A M I C E, at Dublin Congress of the Royal Institute of Public Health, August, 1898

the row or block as the case may be, excepting in so far as the whole volume of gases commingle in a main flue beyond the cells

In the case of the two makes with which the principle of "mutual assistance" has been most fully developed the drying hearth has been entirely dispensed with With Heenan's "Twin Cell" the drying process takes place in each cell alternately, and with Meldrum's "continuous grate" the drying process is carried on in different parts of the one cell from end to end successively as charged.

The striking difference between these two makes and single cells will be at once apparent, in the former case the drying or evaporation of moisture is more rapid further instead of slow distillation of volatile gases the process is accelerated and the volume of low temperature volatile gases at all times very small by comparison with the very large volume of high temperature gases present must quickly ignite in the cell

The drying hearth as distinct from the grate proper is an integral part of the cell in every system of single or isolated cells It therefore follows that in addition to cremating its charge of refuse each cell has another function and one which is to some extent antagonistic to the main purpose Owing to the presence of a quantity of ordinary refuse on the drying hearth in the cell there must be a definite loss in temperature owing to the constant absorption of heat by the escaping gases distilled from the drying hearth

Each single or isolated cell is therefore called upon to fulfil two objects at the same time viz drying or slow distillation of volatile gases and cremation or combustion The former is a constant process in *every such cell* the latter process being broken by the intervals of burning down or reduced activity during clinkering and charging

While it will be obvious that a dry charge pulled from the drying hearth is so far beneficial it must be equally clear that the dry charge is only obtained at a sacrifice of the cell temperature as a whole and therefore the drying hearth is by no means so advantageous as is commonly supposed

An easy continuity of high temperature working being a

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An easy continuity of high temperature working being a

matter of supreme importance, even if the *desideratum* be cremation pure and simple, it might be reasonably urged that in order to secure the first essential, it would be worth while, if found necessary, to make a sacrifice in another direction. It will, however, be readily observed that in effectually securing an easy continuity of high temperature working, no sacrifice is involved either directly or indirectly, but, on the other hand, the gain is very material and comprehensive.

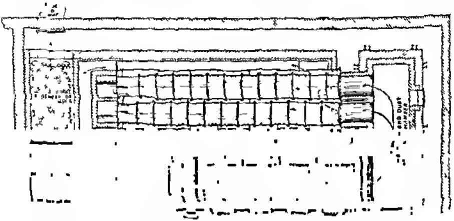

FIG. 37. MELDRUM'S PATENT "CONTINUOUS GRATE"—the equivalent of four ordinary cells. The gases have a sideway motion into the Combustion Chamber, thence to the Boiler.

FIG. 38. HEENAN'S PATENT "TWIN CELL"—the equivalent of two ordinary cells. The gases usually have a sideway motion into the Combustion Chamber, thence to the Boiler.

Firstly—Owing to the minimum of fluctuation in the cell temperature, the cell as a structure suffers less, being subjected to the minimum of strain from expansion and contraction

Secondly—Nuisance, in the way of escaping noxious fumes, is absolutely impossible

Thirdly—The continuity of high temperature working is of the highest importance when the Destructor is combined with a power plant, because—

(*a*) The maximum evaporative efficiency is secured, and

(*b*) The steam pressure is kept steady, which is desirable in every case where the power is fully utilized, but imperative where steam is supplied to an electricity works

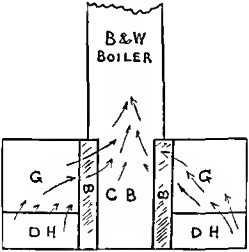

FIG 39 THE STERLING PAIR CELL SYSTEM, with Combustion Chamber arranged centrally, the gases passing from the right and left hand cells into the Combustion Chamber, thence to the Boiler

Steadiness in steam pressure is only possible when the gases coming into contact with the heating surface of the boiler are steady in temperature, and so, to go back to the beginning, steady temperature of the gases at the boiler is only possible by ensuring steady temperature of the gases *in the cell or cells* as the case may be

Those who may consider that too much stress is laid upon the necessity for perfect combustion *within the cell*, should not forget

that if unconsumed gases once reach the chimney, nothing can be done to avoid nuisance, such gases being heavier than air will certainly descend after cooling

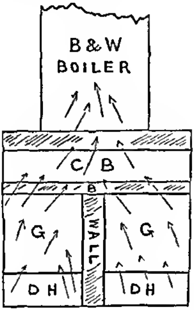

FIG 40 MELDRUM'S BEAMAN & DEAS TYPE PAIR CELL system The gases passing from the right and left hand cells into the Combustion Chamber behind thence to the Boiler

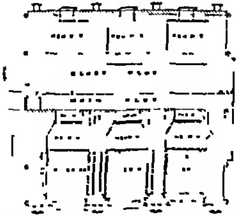

FIG 41 HORSFALL'S TOP FED TYPE arranged back to back in a block the boiler or boilers being placed at the right hand end of the main flue Each cell is separate and distinct the gases therefrom leaving at the front and passing into the main flue at the back, thence to the boiler

Having this clearly in mind, and realizing its importance, is it not advisable to begin at the beginning, aiming at an *initial high temperature?* If this be done, then nuisance is rendered

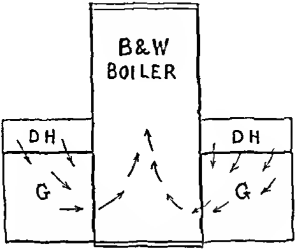

FIG 42 FRYER'S IMPROVED TOP FED TYPE—a Babcock & Wilcox boiler being set between two cells. The gases upon leaving the cells come into immediate contact with the boiler tubes

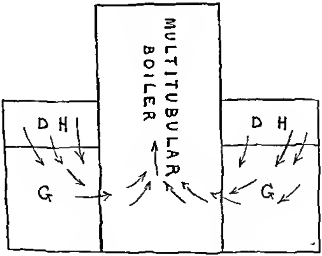

FIG 43 WARNER'S PERFECTUS TOP FED TYPE a Multitubular boiler being set between two cells The gases upon leaving the cells come into immediate contact with the boiler

absolutely impossible, and the theoretical advantages of such a principle are fully realized in practice

Figs 37 to 44 are in plan, and for the most part diagrammatic only but they will serve to show the salient features in design

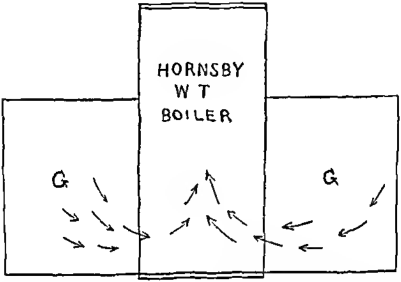

FIG 44 BAKER'S IMPROVED TOP FED TYPE a Hornsby boiler being set between two cells The gases upon leaving the cells come into direct contact with the boiler tubes

G = Grate
D H = Drying Hearth
C B = Combustion Chamber
B = Bridge
The arrows in each case indicate the course of the gases from the cell to the boiler

which have for their object "mutual assistance" In the case of the single cell systems it will be observed that no combustion chamber is provided with three different systems the gases from a pair of divided or isolated cells commingle when immediately under the boiler

Taking the four systems in the other group it will be observed

that with two makes the gases must commingle in the cell, and still further in the combustion chamber, while with the two other makes in this group the provision of a common combustion chamber ensures the intermingling of the gases before the boiler is reached

Chapter XV

THE COMPARATIVE ADVANTAGES OF VARIOUS TYPES OF STEAM BOILERS FOR USE WITH DESTRUCTORS

THIS work would be incomplete without some reference to the boiler question A careful perusal of all the available literature on the subject would seem to indicate a strange reluctance upon the part of the various writers to express any decided views concerning boilers

Generally speaking the choice lies between Lancashire and Water Tube boilers A number of Cornish boilers are used for small installations and also not a few Multitubular boilers but boilers of the latter type are unsuitable and inefficient and are no longer adopted in connection with modern high temperature Destructor installations

An effort has been made to introduce Dry Back Marine" or Fire Tube boilers but this type has not yet been tried neither Municipal authorities nor Destructor makers apparently caring to make the experiment Although this type of boiler would undoubtedly prove to be more efficient than the multitubular type yet serious and constant trouble would undoubtedly be experienced owing to the rapid accumulation of dust in the tubes Further as at present designed it may be gravely doubted whether anything like sufficient area would be available for the passage of the gases from a Destructor of reasonable size

Referring to the multitubular boilers in use with the Destructor at Ashton under Lyne, Mr Neville Applebee wrote as follows —

'The 3½ inch fire tubes in the multitubular boilers get rapidly choked and seriously reduce the effective heating surface'[1]

Even if the area will permit of a reasonably large volume of gases being passed through the fire tubes the question of dust deposit has still to be faced In spite of all reasonable attention the *heating surface is never clean and wholly exposed* for many hours at a time

In considering the question of suitable boilers it will therefore be clear that the choice must be between Water Tube Lancashire and Cornish boilers As already observed however the use of Cornish boilers is limited to small installations such as Destructors combined with sewage works the steam being used for pumping purposes and the work usually being of a steady character

For work of this kind the Cornish boiler is very suitable in fact it would be difficult to improve upon the results obtained and so far as one is able to judge under such circumstances nothing would be gained by substituting water tube boilers for Cornish boilers In larger combined sewage and Destructor works Lancashire boilers have been mostly installed and experience has shown that this type of boiler is well adapted for the work

The *more critical test* of the boiler is *in connection with the* combined Destructor and electricity works but it will frequently be found exceedingly difficult to make comparison between water tube and Lancashire boilers owing to the great variety of working conditions It may for example be reasonably submitted that fair comparison cannot be made between the results obtained with one water tube boiler working in connection with a four grate unit Destructor of the hand fed type and another water tube boiler working in connection with four single cells of the top fed type The difference in boiler efficiency may be entirely due to the radical difference in the design of the two Destructors and this being so it would be manifestly unfair to adversely criticize the performance of the boiler

[1] See the *Electrician* December 5 1902

While the reader may with advantage compare the various steam pressure diagrams herein reproduced, it would be idle to pretend that these diagrams are conclusive, nevertheless, such charts clearly emphasize the general superiority of the Lancashire boiler for steady steaming The steam pressure charts cover a wide variety in design and, likewise a variety of working conditions but every chart here included represents ordinary working conditions, and is therefore of value for purposes of comparison

In studying the diagrams, the student must be impressed with the unsteady steaming shown with water tube boilers It will be observed that in some cases the percentage of fluctuation is very serious indeed

To briefly summarize the comparative advantages of water tube and Lancashire boilers In the case of the former, it is possible to instal a greater amount of heating surface in a given space and a greater absorption of radiant heat is ensured than is the case with the Lancashire boiler Then the question of space is often a very serious one, more particularly, perhaps, in London and in other large cities and towns where land is valuable

The Lancashire boiler has large steam and water space and also possesses the merit of extreme simplicity, both of which are features of great importance The large steam and water space is of the highest utility, making as it does for steady steaming which is essential where the power is being used for electrical purposes

The water tube boiler while being a rapid steam raiser, is also a rapid steam loser, possessing but a limited amount of steam and water space On the other hand the Lancashire boiler, by reason of its large storage capacity for steam and water, has a goodly reserve of power, which is of immense value in connection with the power Destructor, being a most useful set off against possible fluctuations in the quality and condition of the refuse, and also laxity on the part of the men, as will happen occasionally

One of the highest authorities on steam boilers in this country, Mr C E Stromeyer, M I C E, recently expressed the following

opinion concerning the comparative advantages of various types of steam boilers —[1]

> I will conclude by remarking that as matters stand at present Lancashire boilers with economisers are doubtless the most efficient as regards economy and upkeep, but they occupy much floor space Marine boilers of course without economisers, are nearly as efficient and seem to require practically no repairs They occupy about half as much floor space as Lancashire boilers, but cost considerably more Economic and Water Tube boilers are practically on a level as regards economy and floor space In both cases the heavy brickwork is a constant source of loss through air admission

While it is true that Mr Stromeyer's remarks specifically refer to boilers fired with coal, yet his conclusions are equally applicable to boilers fired with Refuse Destructor gases In the latter case, however, marine type and "Economic" boilers would necessarily be less efficient for reasons already explained, i e the constant choking up of the tubes with dust

It is unnecessary to deal at any length here with the question of feed water it being now clearly recognized that where the water is of a sedimentary nature a water purifying apparatus must be installed with a water tube boiler, and where the comparative cost of Lancashire and water tube boilers is being considered the cost of such apparatus should be added to that of the latter type

That there is a field for both types of boiler is beyond question, each has advantages not possessed by the other and likewise disadvantages For many small electricity undertakings the water tube boiler will always be popular lending itself as it does to supplementary coal firing, and thus in the early days of small electricity undertakings saving the cost of at least one separate coal fired boiler

As with the type of draught, so with the type of boiler, the subject will always be a controversial one, but alike in both cases all the advantages are by no means on the one side

[1] *The Choice of a Steam Boiler* By C E Stromeyer, M I C E Chief Engineer, Manchester Steam Users Association See *Proceedings of Civil and Mechanical Engineers Society* 1903

Chapter XVI

REFUSE DESTRUCTORS IN THE METROPOLITAN BOROUGHS, LONDON

COMPARATIVELY speaking, very slow progress is being made in the Metropolitan Boroughs in the final and sanitary disposal of refuse In so large a city this is to be regretted the more so, perhaps when it is borne in mind that the other methods of disposal in vogue are very costly, and generally speaking unsatisfactory

It cannot be deemed satisfactory when large Metropolitan Boroughs inflict their filth upon other smaller communities in Urban Districts, and such a method does not even possess the saving grace of economy The system is most expensive, and it has been clearly demonstrated wherever Destructors have been erected, with the exception of Battersea, that the cost of disposal has been materially reduced

In the case of Battersea, it is not the system which is at fault The Destructor was erected some fifteen years since, on a site which has in the course of time proved to be anything but central The Battersea of to day is so thickly populated, and has so extended in other directions, that the Destructor site which fifteen years ago was reasonably central, is now in a corner of a large Borough, and so the cartage cost has increased alarmingly

With this single exception the destruction of refuse within the Borough where it is produced has been beneficial to the ratepayers financially, although they may not always recognize it as such

A glance at Fig 45 will at once make clear the actual progress which has been made up to the present. It is safe to say that ten years hence it will be possible to present a very different chart. So increasingly *difficult is it becoming* to *get rid of London's* waste that the Destructor is generally recognized to be the only solution. It is quite certain that if it were not possible to inflict the filth upon Urban communities, the London of to day would be far better equipped with Destructors than is the case.

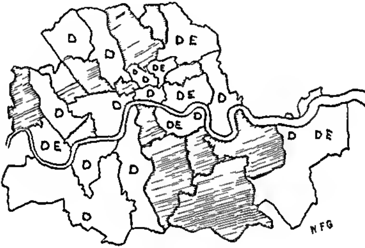

FIG 45

THE METROPOLITAN BOROUGHS

D — Destructor in use
DE — Destructor combined with electricity works in use
Hatched Sections — Boroughs without Destructors

There are distinct signs that the present method of mere riddance will have to cease. It is becoming increasingly evident that small Urban communities strongly object to being made the dumping ground of the stale filth of London, and when these small communities adopt Destructors to deal with their own waste, as they are now rapidly doing, it is only reasonable to expect that difficulties will arise, and that the available dumping grounds for London's filth will gradually diminish, as is indeed the case already.

A = Date of Erection
B = Make and Type of Destructor
C = Number of Cells
D = Number and Type of Boilers
E = Height of Chimney
F = Type of Draught used.
G = Purpose for which Power is used
H = Weight of Refuse Destroyed Daily
I = Labour Cost per Ton of Refuse Destroyed
J = Average Number of Board of Trade Units Generated per Ton of Refuse Destroyed.

E W = Destructor combined with Electricity Works
S W = Destructor combined with Sewage Works
E W S W = Destructor combined with both Electricity and Sewage Works

Battersea—Population 168 907

A	1888
B	Fryer's top fed
C	12
D	1 Multitubular
E	180 feet
F	Natural draught only
G	Clinker crushing etc
H	60 tons
I	2s

Bermondsey—Population 130 486

Two Installations

	1	2 E W
A	Rotherhithe 1891	Bermondsey 1902
B	Meldrum's Beaman & Deas top fed	Sterling top fed
C	2	6[1]

[1] It has recently been decided to erect two additional cells.

D	1 Babcock & Wilcox.	3 Babcock & Wilcox
L	150 feet	150 feet
F	Fan	Fan
G	Fan engine Works Lighting and Disinfector	Electric Lighting and Public Baths
H	25 tons	80 tons
I	1s	—

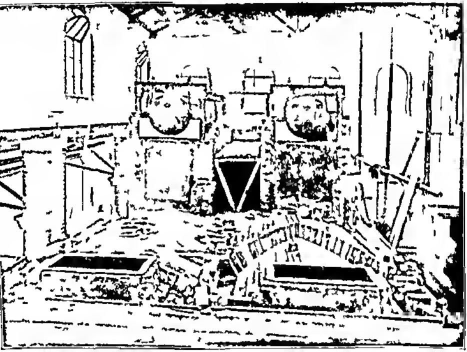

FIG 46 ROTHERHITHE DESTRUCTOR
In Course of Erection

The three Babcock & Wilcox boilers in connection with the Destructor are arranged for coal firing either in conjunction with or independently of the gases from the Destructor while additional coal fired boilers are also installed

The power equipment of the station is as follows —three Willans' engines direct coupled to three Thames Iron Works

Dynamos of a total capacity of 375 K W Tudor cells are also provided having a capacity of 24 K W for 6 hours

This combined works has a very successful record largely due to the excellent day load The following details are taken from a report covering the first nine months' working ending in March 1903

The steam supplied to the Public Baths effected a saving in wages and coal of £541 The sum of £272 was saved by destroying trade refuse as compared with the previous cost of barging this material away A portion of the clinker was utilized for making paving flags at a cost of £427 To purchase a similar quantity of flags would have cost £1 521 Some 000 tons of clinker was also used for making concrete at a saving of £58

Figure 46 is a view of Meldrum's Beaman & Deas type of Destructor in course of erection at Rotherhithe

CITY OF LONDON—POPULATION 37 705

LETTS WHARF DESTRUCTOR

A	1884
B	Fryer's top fed
C	10
D	1 Multitubular
E	150 feet
F	Natural draught only
G	Hoist and shaft charging

During the year 1902 the Destructor was in constant use both day and night with the exception of stoppages totalling 84¼ days for repairs and flue cleaning 26 245 loads of refuse were destroyed yielding a residuum of 4 737½ loads of clinker and ashes

Negotiations are just now being concluded for the purchase of 130 acres of land at Hornchurch Marshes near Barking having a river frontage of 1 700 feet This land which will cost the city £23 411, will be used as a Refuse tip

Finsbury—Population, 101,463

Two Installations

	1	2
A	St Luke's, 1899[1]	Phoenix Wharf, 1899
B	Horsfall's top fed	Baker's top fed
C	6	2
D	1 Multitubular, 14 ft by 8 ft	1 Hornsby Water Tube
F	Steam Jet Blowers	Fan
G	Clinker Crusher, Mortar Mill, Works Lighting	Fan Engine only
H	50 tons	15 tons[2]
I	8½d	

Some details of analytical tests of the gases taken both from the main flue and chimney at installation No 2 (Baker's Destructor) are here given —

Gases from Main Flue (5 samples), analysed by Mr J Kear Colwell, F I C March 7 1902

No of Sample Time of Collection	A 3 50 p m	B 4 5 p m	C 4 20 p m	D 4 45 p m	E 5 5 p m
Pyrometer reading	515° F	550° F	530° F	550° F	560° F
Carbon Dioxide	7·0%	5·6%	4·3%	5·9%	7·0%
Carbon Monoxide	0·0%	0·0%	0·0%	0·0%	0·0%
Oxygen	12·2%	12·1%	14·3%	12·0%	11·0%
Nitrogen	80·0%	82·4%	81·4%	82·0%	81·4%
Olefines and Heavy Hydrocarbons	0·4%	0·0%	0·0%	0·0%	0·0%
Marsh Gas	0·4%	0·0%	0·0%	0·0%	0·0%
Percentage of Free Air	58·1%	57·1%	68·1%	57·1%	52·3%

[1] This installation replaced a six cell plant of another make erected in 1893

[2] A sorting process is carried on at these works and the weight of material destroyed daily varies considerably Only paper cardboard, straw, garbage etc is destroyed the heavy material being abstracted

GASES FROM CHIMNEY (6 samples), analysed by Mr J Kear Colwell, F I C, February 26, 1902

No of Sample Time of Collection	A 1 30 p m	B 2 20 p m	C 3 20 p m	D 4 5 p m	E 4 30 p m	F 5 p m
Pyrometer reading	350° F	410° F	410° F	410° F	430° F	410° F
Carbon Dioxide	5.1%	5.7%	4.8%	3.2%	3.0%	5.0%
Carbon Monoxide	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Oxygen	14.2%	13.4%	11.8%	14.1%	14.0%	13.8%
Nitrogen	79.9%	80.9%	83.2%	82.4%	82.0%	81.0%
Olefines and Heavy Hydrocarbons	0.1%	0.0%	0.2%	0.0%	0.1%	0.2%
Marsh Gas	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percentage of Free Air	67.6%	63.8%	70.5%	68.0%	66.6%	65.7%

E W FULHAM—POPULATION, 145,000

A	1901
B	Horsfall's top fed
C	12
D	6 Babcock & Wilcox
E	*100 feet*
F	Steam Jet Blowers
G	Electric Lighting
H	100 tons
I	1s 0.88d[1]
J	26.02[1]

The six water tube boilers working in connection with the Destructors are arranged in a battery between two blocks of cells. These boilers are also equipped with mechanical stokers and forced draught, so that the boilers may be coal-fired either independently of or in conjunction with the Destructor gases.

Three boilers of the dry back marine type have since been installed for coal-firing only. Green's economisers are also provided in two batteries of 96 pipes each.

The power equipment of the station is as follows—Three Musgrave slow speed, compound engines total H P, 1500, direct coupled to three two phase General Electric Company's Oerlikon Dynamos, total capacity, 900 K W

[1] Average for the year 1902

DESTRUCTORS IN THE METROPOLITAN BOROUGHS

Mr A J Fuller, the Borough Electrical Engineer, recently prepared a report for the Electricity Committee reviewing the operation of the Destructor for the year 1902. A few extracts from this report will doubtless be of interest—

Total weight of Refuse burned	30 000 tons
Total weight of Clinker barged away	16 000
Cost per ton for barging	3 7*d*
Labour cost per ton of Refuse burned	1*s* 6 88*d*
Repairs cost per ton of Refuse burned	2 07*d*
Management costs per ton of Refuse burned	1 44*d*
Average number of electrical units generated per ton of Refuse burned	26 62

Some details of an evaporative test in connection with the Destructor are here given—

Date of Test	December 17 1901			
Duration of Test	16 hours			
Number and Type of Cells	12 Horsfall Cells Back to-back Top-fed			
Total Grate Surface	360 square feet			
System of Forced Draught	Horsfall Co s Patent Steam Blowers.			
Nature of Refuse	House and Market			
Number and Type of Boilers	Six Water Tube			
Economiser—Number of Tubes	Two Economisers each 96 Pipes			
	tons	cwt	qrs.	lb
Total quantity of Refuse burned	83	18	0	0
Total quantity of Refuse burned per cell per 24 hours	10	9	3	0
Total quantity of Refuse burned per sq ft of grate per hour	32 6 lb			
Tons per man per shift	6	19	3	2
Total Water evaporated	96	17	0	20
per hour	6	1	0	8
per sq ft of heating surface per hour	1 8 lb			
Total Water evaporated per lb of refuse from and at 212° F or 100 C.	1 3 lb			
Mean Steam Pressure	137 lb			
Feed Temperature	48 5			
Main Flue Temperature	1 800 F			
Temperature behind boilers	3[illegible]0 F			

The general arrangement of the installation may be seen by referring to Figure 47 It will be observed that the boilers are all set in a battery while the cells are arranged in two groups of six each back to back

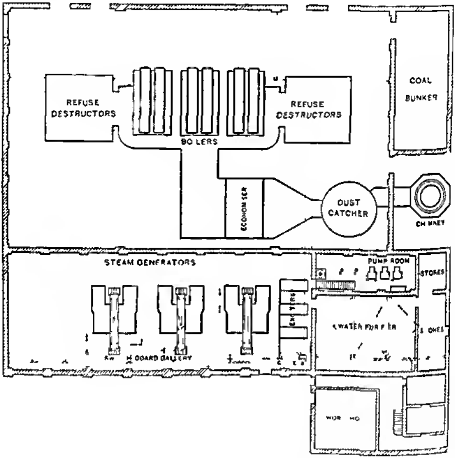

FIG 47 FULHAM COMBINED DESTRUCTOR AND ELECTRICITY WORKS
Plan

F W HACKNEY—POPULATION 219 288

A	1902
B	Sterling top fed
C	12
D	3 Bal cock & Wilcox
I	200 feet

F	Fans
G	Electric lighting
H	120 tons[1]
I	1s 7 1d[1]

Details of an evaporative test are here given—

Date	December 4 and 5, 1902
Barometer	30 21 to 30 54
Atmospheric Temperature	29° F to 36° F
Weather	Fine
Character of Fuel	Unscreened Ashbin Refuse
Number of Cells used	12
Number of Boilers used	3
Economiser—Number of Tubes	288
Duration of Test	19 hours
Average hours worked per cell	17 9
Refuse burned—Total tons	133 tons 15 cwt 1 qr 21 lb
,, ,, ,, lbs	299,649
,, ,, per cell hour	1,393 lb
,, ,, per cell per 24 hours	14 8 tons
Feed Water Temperature—Suction Tank	51 8° F
Feed Water Temperature leaving Economiser	220 6° F
Water evaporated—Total actual	11,751 galls
,, ,, ,, ,,	117,510 lb
,, ,, per hour	[illegible] lb
Average Steam Pressure above atmosphere	181 lb
Water evaporated per pound of Refuse—actual	1 159 lb
Water evaporated per pound of Refuse from and at 212° F	1 415 lb
Temperature of Flue Gases in main flue before economiser	537° F
Temperature of Flue Gases in main flue after economiser	[illegible] F
Average Air Suction at foot of shaft in inches of water	1 01
Average Air Pressure at Fan Outlets	[illegible]
Average Air Pressure in Ashpits	2 23
Units (kilowatt hours) generated from refuse steam during test by engines running non condensing actual	7 247

[1] Average for year ending March 31, 1902

Average units per hour, actual non condensing	381
Average hourly E H P actual non condensing	511
Units generated per ton Refuse burnt actual non condensing	54 19
Total units used for forced draught during test	553
Percentage used for forced draught of actual total power raised from Destructor Steam, non condensing	7 63
Units per ton Refuse for Fans	4 13
Total units consumed in elevating Refuse	39 70
Units per ton of Refuse	0 296

The complete figures for the first year's working ending March 31, 1903, are here given and will be found of interest—

ANALYSIS OF ACCOUNTS FOR YEAR ENDED MARCH 31, 1903

I.—STATEMENT OF CAPITAL

Amount of Loans Sanctioned	Amount Borrowed	Amount Repaid	Capital Expenditure
£29 000	£29 000	£1,268	£30,224

II.—DESTRUCTOR RECORDS

1	Quantity of Refuse destroyed		34 000 tons
2	Largest Quantity destroyed in one day		186 „
3	Smallest Quantity destroyed in one day		41 „
4	Average Quantity destroyed daily		120 „
5	Bye Product —		
	Clinker, Fine Ash, and Flue Dust	11,578	
	Tins Cans and Scrap Iron	120	„
	Total	11 698	
6	Total Quantity of Water evaporated and utilised by Electricity Department	41 411 970 lbs	
7	Total Quantity of Water evaporated per lb of Refuse		54 „

III.—REVENUE

		Amount	Per Ton of Refuse Destroyed
		£	d
1	Revenue from supply of steam to Electricity Department	2 272	16 0
2	Sundry Receipts	8	1

	Amount	Per Ton of Refuse Destroyed
3 Balance being net cost to Public Health Department of destruction of Borough Refuse	£ 5 020	d 35 4
Total Revenue	£7 300	51 5d

IV —Expenditure

	Amount	Per Ton of Refuse Destroyed
	£	d
1 Oil Waste Water and Stores	61	4
2 Electricity for Lighting and Power	660	4 7
3 Wages of Workmen	2 708	19 1
4 Repairs and Maintenance	48	3
5 Clinker Disposal	747	5 3
6 Management Expenses	304	2 1
	£4 528	31 9
7 Interest on Loans	944	6 7
8 Sinking Fund	1828	12 9
Total Expenditure	£7 300	51 5d

The fuel cost per unit generated is given as 48d and the total costs 1 03d The load factor 15 88% is likely to improve, and this will of course widen the scope of usefulness for the Destructor

Hampstead—Population 81 942

A	1888 1890 and 1897
B	Fryer's top fed
C	14
D	None
E	Two chimneys each 120 feet
F	Natural draught only
G	No power available
H	100 tons

KENSINGTON—POPULATION, 176,623

A	[1]
B	Warner's top fed
C	22
D	Two Multitubular
E	150 feet
F	Fans
G	Works purposes only
H	150 tons

The estimated total cost of this plant is £30,513 6*s* 0*d* and included in the scheme is a disinfector station laundry, and foreman's house and offices

LAMBETH—POPULATION, 301 895

A sixteen cell Destructor, of the improved Fryer type was erected here in 1900 by the South London Electricity Corporation Limited It was intended to utilize the power for electric lighting eight Babcock & Wilcox boilers being provided each boiler being set between a pair of cells but after a few months' working the destructor was stopped, and has not been operated again up to the present time

POPLAR—POPULATION, 168,838

A	1898
B	Warner's top fed
C	14
D	1 Multitubular
E	150 feet
F	Fan
G	Fan engine clinker crusher and mortar mill
H	96 tons
I	1*s* 10½*d*

The cost of this installation was about £8 400, exclusive of the cost of the site and the chimney

[1] This installation is not likely to be completed until the end of 1901

St Pancras—Population, 235,284

A	1894 and 1895
B	Warner's top fed
C	18
D	4 Hornsby water tube
E	207½ feet
F	Fans
G	Fan engine clinker crusher and mortar mill
H	100 tons
I	1s 1¾d

The total cost of this installation was £21,000, exclusive of the cost of the site but including the cost of heavy retaining walls A considerable quantity of mortar is made, for which there is a steady demand at 5s per ton

F W Shoreditch—Population, 118 705

A	1897
B	Fryer's improved top fed including Boulnois Wood & Brodie's patents
C	12
D	6 Babcock & Wilcox
E	150 feet
F	Fans
G	Electric lighting
H	100 tons
I	2s 3¾d

The total cost of the installation exclusive of site was £20 527 The average electrical output per ton of refuse destroyed taken over one year is given as 20 units The electrically driven fans for providing forced draught use four units per ton of refuse destroyed while 5 units per ton of refuse handled is used by the electric hoists and tipping trucks

This installation has been the subject of much discussion but not a little of the criticism has been based upon erroneous ideas It is but fair to state this and to point out that with the plant now installed having a total capacity of nearly 2 500 K W it would be impossible for any Destructor to supply but a fraction of the total power required

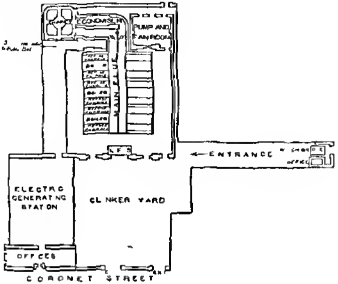

Fig. 48. Shoreditch Combined Destructor and Electricity Works
Plan

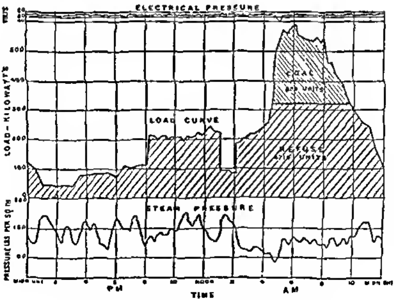

Fig. 49. Results of Test January 10, 18[illegible]

The question of design has already been fully discussed in

another chapter, and although this must effect the general efficiency yet the fact remains that at Shoreditch, as in every other combined works, the maximum benefit from the Destructor could

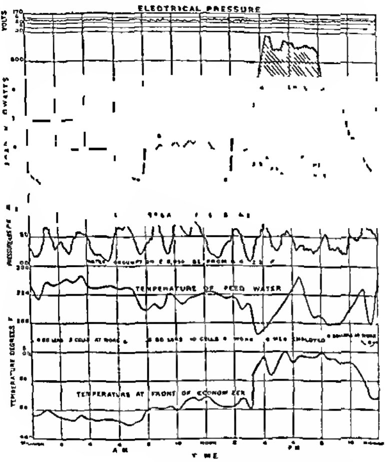

FIG 60 RESULTS OF 24 HOUR TEST DECEMBER 6 1898

only reasonably be expected during the first year or two of operation

Apart altogether from the power aspect the refuse is disposed of more cheaply than under the old system of riddance which owing to the difficulties of disposal becomes increasingly expensive

year by year It is but fair to bear in mind that even if the amount of power produced has fallen short of expectations yet Shoreditch possesses a system of final and sanitary disposal which might well be emulated by many other Metropolitan Boroughs, who continue at huge expense to inflict their filth on other communities

The general arrangement of the Shoreditch installation, which will, however, be familiar to many readers, is shown in Fig 48, while Figs 49 and 50 are of interest as combined diagrams

STEPNEY—POPULATION, 298,548

A	1900
B	Fryer s improved top fed
C	12
D	6 Babcock & Wilcox
E	180 feet
F	Fans
G	Electric lighting
H	165 tons
I	1s 4 9*d*
J	32

The cells are arranged in single row, and the works are kept in a very clean condition The total cost of the installation was £17,740, 16*s* 0*d*, exclusive of the site In addition to the Destructor boilers, three supplementary coal fired boilers of the Babcock & Wilcox type are provided The power equipment of the station is as follows.—5 Willans engines, and 6 Mather & Platt dynamos, having a total capacity of 1,220 K W, also 260 Tudor cells, of 800 ampère hours' capacity

Some interesting figures, extracted from the accounts for the year ending March 31, 1902, are here given

ELECTRICITY GENERATED

From steam taken from the boilers of the Refuse Destructor . .	868,543	Board of Trade units
From steam raised in coal fired boilers	279,758	„ „
Total . . .	1,148,301	„ „ „

COST OF STEAM

	£	s	d
Total cost for steam from Refuse Destructor boilers, 868,546 B T U at 3d (or about 3 B T U for 1d)	1,085	13	8
Steam raised in coal fired boilers 279 758 B T U (equals 8½d per unit)	989	6	1

Fig 49, which is a reproduction from a steam pressure chart, is of interest for purposes of comparison, not only with diagrams obtained with Lancashire boilers, but also with others here reproduced from combined works, where the general design of the plant differs from that at Stepney

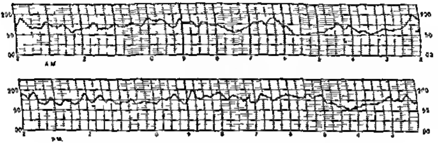

FIG 49 STEPNEY COMBINED DESTRUCTOR AND ELECTRICITY WORKS
Steam Pressure Diagram

WANDSWORTH—POPULATION, 232,030

A	1899
B	Meldrum s Beaman & Deas top fed direct charged
C	4
D	1 Babcock & Wilcox
E	150 feet
F	Fan
G	Works purposes only
H	70 tons
I	7½d

The cost of this installation was £5 005 including the chimney but not including the inclined roadway The complete details of a test of 120 hours' duration are here given, this test was carried out under ordinary working conditions, and mainly with a view to ascertaining the actual value of the Wandsworth refuse for power producing purposes The whole of the clinker is readily disposed of at the works at 1s 9d per cubic yard, the purchasers carting the same away themselves

METROPOLITAN BOROUGH OF WANDSWORTH

Result of Six Days' Continuous Test (February 2 to 7 Inclusive) at the Destructor Depot, Lower Tooting

Particulars	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Totals
Time of Start	9 25 a m	—	—	—	—	—	—
Finish	—	—	—	—	—	9 25 a m	—
Duration of Test	14 hrs 35 min.	24 hours	24 hours	24 hours	24 hours	9 hrs 25 min	120 hours
Weather	Very cold	Very cold	Moderately cold	Mild	Mild	Mild	—
Type of Furnace	B & D	B & D	B & D	B & D	B & D	B & D	Beaman & Deas
Charging Apparatus							Marten's Patent
No of Cells or Grates	2	2	2	2	2	2	2
Effective Grate Area (per cell 25 sq feet)	50	50	50	50	50	50	50 sq ft
Type of Boiler	B & W	B & W	B & W	B & W	B & W	B & W	Babcock & Wilcox
Heating Surface of Boiler	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft
Total Weight of Refuse including Tins—183 tons 18 cwt—411 264 lb	60 365 lb	74 116 lb	78 652 lb	86 352 lb	87 444 lb	24 332 lb	411 264 lb
Weight of Tins—23 [illegible]	107	134	140	153	155	42	7 3[illegible]
No of Times No 1 Furnace Charged	8	11	11	13	12	3	58
No of Times No 2 Furnace Charged	8	11	12	12	12	4	59
Average Weight of each Charge	3 766 lb	3 354 lb	3 4[illegible]0 lb	3 453 lb	3 643 lb	3 444 lb	3 509 lb
Weight of Refuse burned—183 tons 5 cwt 2 qrs	60 261 lb app	73 99[illegible] lb app	78 512 lb app	86 199 lb app	87 289 lb app	24 290 lb app	410 536
Weight of Refuse burned per hour	4 132	3 062	3 [illegible]1	3 591	3 637	2 578	3 421
Weight of Refuse burned per sq ft Grate per hour	82 06	61 06	65 42	71 7	72 7	51 5	68 4
Weight of Refuse burned per sq ft of Boiler Heating Surface per hour	2 5	1·03	2 02	2 2	2 2	1 5	2 1
Residuals— tons cwt qrs							
Clinker 68 16 0	—	—	—	—	—	—	154 112
Flue Dust 1 12 3	—	—	—	—	—	—	3 668
Ashpit Dust 0 18 3	—	—	—	—	—	—	2 016
Total 71 7 2	—	—	—	—	—	—	159 796
Proportion of Clinker to Refuse burned	—	—	—	—	—	—	37%
Proportion of Flue Dust to Refuse burned	—	—	—	—	—	—	8 of 1%
Proportion of Ashpit Dust to Refuse burned	—	—	—	—	—	—	

Weight of Water Evaporated Average per hour (actual)	3 844 lb app	2 330 lb app	3 500 lb app	3 834 lb app	3 834 lb app	2 960 lb app	3 499 lb
Weight of Water Evaporated from and at 212 F	4 766	3 509	4 340	4 754	4 754	3 6 0	4 334
Weight of Water Evaporated per lb of Refuse (actual)	93	94	1 07	1 06	1 06	1 15	1 02
Weight of Water from and at 212° F	1 15	1 12	1 37	1 32	1 37	1 4	1 24
Weight of Water per sq ft H S from and at 212° F	2 9	2 1	2 6	2 9	2 9	2 2	2 6
Maximum Temperature at Boiler Inlet	About 2 000	About 2 000	About 2 000°	About 2 000	About 2 000	About 2 000°	[illegible]
Approximate Average Temperature at Boiler Inlet	1 695 F	1 639 F	1 714° F	1 716° F	1 744 F	1 704 F	1 694 F
Maximum Temperature at Boiler Outlet	710 F	715° F	750° F	795° F	750° F	765 F	765 F
Average Temperature at Boiler Outlet	619° F	698 3° F	649 22° F	653 9 F	660° F	635 F	637 F
Maximum Temperature at Chimney Base	690° F	700 F	725° F	725° F	740 F	725 F	710 F
Average Temperature at Chimney Base	596 8° F	573 2° F	619 1° F	651 45 F	657 5 F	614 F	672 F
Average Ashpit Pressure (No 1 Furnace)	2 5 in	2 73 in	2 653 in	2 604 in	3 0 in	3 0 in	2 76 in
Average Ashpit Pressure (No 2 Furnace)	2 44	2 04	2 49	2 24	2 75	2 675	2 41
Average on Nos 1 and 2 Furnaces	2 49	2 135	2 56	2 44	2 87	2 83	2 55
Maximum Ashpit Pressure (No 1 Furnace)	3 5	3 25	4 0	3 5	5 25	4 25	5 75
Maximum Ashpit Pressure (No 2 Furnace)	3 0	3 12	4 0	3 0	4 5	4 5	4 5
Maximum Pull in Flue at Boiler Outlet	—	—	5675	5625	5625	5675	6
Minimum Pull in Flue at Boiler Outlet	—	—	5	375	5	5	168
Average Pull in Flue at Boiler Outlet	—	—	531	534	531	562	518 5
Maximum Pull at Chimney Base	5	3 5	812	812	812	812	667
Minimum Pull at Chimney Base	375	312	375	675	625	687	424
Average Pull at Chimney Base	437	375	468	687	75	687	567
CO_2 in Flue Gases	CO_2 / O / CO	CO_2 / O / CO		CO_2 / O / CO	CO_2 / O / CO		
Highest Reading	12 7 / 17 8 / 6	8 3 / 18 4 / 65	—	11 2 / 17 4 / 3	16 6 / 10 9 / 4	—	
Lowest	2 6 / 7 9 / 1	1 7 / 12 1 / 4	—	3 9 / 9 9 / 1	9 5 / 5 5 / 2	—	—
Average	7 4 / 12 8 / 2	4 1 / 16 1 / 2	—	8 2 / 16 6 / 1	14 2 / 8 06 / 19	—	—
Average Temperature of Feed Water	56 5° F	44 7° F	44 4° F	44 3° F	44° F	44 F	44 F

METROPOLITAN BOROUGH OF WANDSWORTH

Result of Six Days Continuous Test (February 2 to 7, Inclusive) at the Destructor Depot, Lower Tooting

Particulars	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Totals
Time of Start	9 25 a m	—		—	—	—	—
Finish	—	—		—	—	9 25 a m	—
Duration of Test	14 hrs 35 min	24 hours	24 hours	24 hours	24 hours	9 hrs 25 min	120 hours
Weather	Very cold	Very cold	Moderate cold	Mild	Mild	Mild	—
Type of Furnace	B & D	B & D	B & D	B & D	B & D	B & D	Beaman & Deas
Charging Apparatus							Marten's Patent
No of Cells or Grates	2	2	2	2	2	2	2
Effective Grate Area (per cell 25 sq feet)	50	50	50	50	50	50	50 sq ft
Type of Boiler	B & W	B & W	B & W	B & W	B & W	B & W	Babcock & Wilcox
Heating Surface of Boiler	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft	1 619 sq ft
Total Weight of Refuse in charging Tins—183 tons 17 cwt = 411 764 lb	61 363 lb	74 116 lb	73 652 lb	86 352 lb	87 444 lb	24 332 lb	411 764 lb
Weight of Tins— 25 lb	107	131	140	153	155	42	728
No of Times No 1 Furnace Charged	8	11	11	13	12	3	58
No of Times No 2 Furnace Charged	8	11	12	12	12	4	59
Average Weight of each Charge	3 766 lb	3 334 lb	3 420 lb	3 453 lb	3 643 lb	3 444 lb	3 509 lb
Weight of Refuse burned—183 tons 5 cwt 2 qrs	60 761 lb app	73 98 lb app	73 512 lb app	86 199 lb app	87 289 lb app	24 290 lb app	410 536
Weight of Refuse burned per hour	4 132	3 082	3 071	3 591	3 637	2 578	3 421
Weight of Refuse burned per sq ft Grate per hour	82 06	61 06	65 4	71 7	72 7	61 5	68 4
Weight of Refuse burned per sq ft of Boiler Heating Surface per hour	2 5	1 93	2 02	2 2	2 2	1 5	2 1
Residuals— tons cwt qrs							
Clinker 68 16 0	—	—	—	—	—	—	154 112
Flue Dust 1 12 3	—	—	—	—	—	—	3 668
Ashpit Dust 0 18 3	—	—	—	—	—	—	2 016
Total 71 7 2	—	—	—	—	—	—	159 796
Proportion of Clinker to Refuse burned	—	—	—	—	—	—	37%
Proportion of Fine Dust to	—	—	—	—	—	—	

WESTMINSTER—POPULATION, 182,977

A	1900
B	Horsfall's top fed direct charged
C	6
D	1 Babcock & Wilcox
E	90 feet
F	Steam Jet Blowers
G	Works purposes only
H	72 tons
I	11 5*d*

The cost of this installation as originally arranged was about £10,000 The complete details of a test conducted by Mr J W Bradley, M I C E, the city engineer of Westminster, are here given

Date of Test	December 2 to 4 1902
Duration of Test	45¼ hours
Number of cells in use	6
Total grate area	232 square feet
Nature of Refuse	House trade and market
Number of firemen and average wage per day	9 Stokers at 30*s* each per week 4 Topmen at 27*s* 6*d* each per week
Number, size and type of boiler	1 Babcock & Wilcox with 1 426 sq ft of heating surface
Total weight of Refuse burned	138 tons 15 cwt 1 qr —310 828 lb
Total weight of Refuse burned per cell per 24 hours	12 tons 5 cwt 1 qr 8 lb = 27 476 lb
Total weight of Refuse burned per square foot of grate per hour	27 2 lb
Labour cost per ton of Refuse burned	11 5*d*
Percentage of Clinker and Ash	24 9 per cent
Mean Steam Pressure	125 lb
Mean Feed Temperature	48° F
Mean Main Flue Temperature	Over 2 000° F
Mean Temperature behind boilers	500° F

Woolwich—Population 117,178

Two Installations

	1	2
	Woolwich	Plumstead E W
A	1893	1903
B	Fryer's top fed	Meldrum's front hand fed
C	6	12 grates
D	—	3 Babcock & Wilcox
E	160 feet	80 feet
F	Natural draught only	Steam jet blowers
G	—	Electric lighting
H	30 tons	80 tons

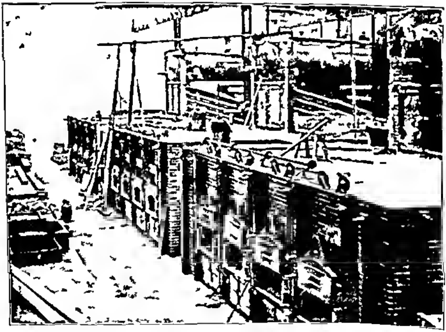

Fig 52 Woolwich (Plumstead) Destructor
In Course of Erection

Installation No 2 is one of the largest Destructors yet erected in this country in combination with an electricity works and it is of a very comprehensive character

Fig 52 shows the Destructor cells and boilers in course of erection while Fig 53 is an external view of the buildings

A clinker brick-making plant, and also a clinker flag press, both designed by Messrs Alexander, of Leeds, are provided, and will serve to utilize the clinker

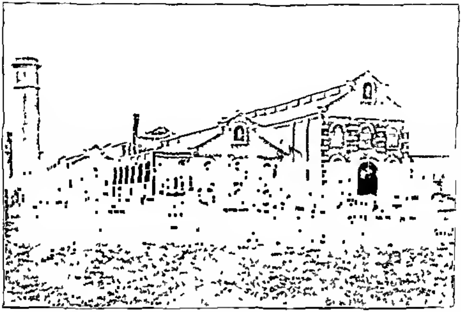

FIG 53 WOOLWICH (PLUMSTEAD) COMBINED DESTRUCTOR AND ELECTRICITY WORKS

View of Buildings

Chapter XVII

REFUSE DESTRUCTORS IN ENGLAND AND WALES

ACCRINGTON MUNICIPAL CORPORATION—POPULATION, 43,122, E W

A	1900
B	Horsfall top fed in single row
C	6
D	2 Lancashire 30 ft × 8 ft
E	250 feet
F	Steam jet blowers
G	Electric lighting
H	60 tons
I	1s 5d
J	25

IN connection with this installation a somewhat novel departure from the usual practice was made, by arranging supplementary coal fired grates between the cells and the boilers, so that the boilers might if desired be fired with coal in addition to the Destructor gases, or in the event of non delivery of refuse coal could be used for the Destructor boilers, even if the cells were idle

While this practice has become quite common with water tube boilers the arrangement had not hitherto been tried with the Lancashire type of boiler

In addition to the two Lancashire boilers in connection with the Destructor one Lancashire boiler is also installed for coal firing alone Among the Destructor accessories is a complete screening and crushing plant for turning the clinker into a marketable product The total cost of the Destructor buildings and chimney, but exclusive of the site, was about £8,000

The power equipment of the Electricity Works comprises 5 Willans & Robinson & Browett Lindley engines, the total H P being 970, the engines are direct coupled to 5 Johnson & Phillips, and Lancashire Dynamo Company's Dynamos, having a total capacity of 580 K W Chloride batteries are also provided, having a capacity of 750 ampère hours

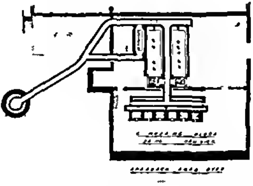

Fig 54 Accrington Combined Destructor and Electricity Works Plan

The figures of a month's log are here given, as also some details of the official test

Fig 54 shows the general arrangement of the cells, boilers and supplementary coal fired grates, between the cells and the boilers

Accrington Corporation Electricity and [illegible] Works

Log for the Month of November 1901

1901		Units generated		[illegible]	[illegible]
November 1					
„ 2					
„ 3	Sunday	Destructors not working			
„ 4		493			
„ 5		814			
„ 6		593	Total		
„ 7		686	for		
„ 8		825	week.		
„ 9		845	4,286	2 457	[illegible]
„ 10	Sunday	Destructors not working			
„ 11		715			
„ 12		802			
„ 13		624			
„ 14		794			
„ 15		895			
16		984	4 814	2 780	[illegible] 100
„ 17	Sunday	Destructors not working			
„ 18		504			
„ 19		908			
20		720			
21		782			
„ 22		835			
„ 23		944	4 693	3 090	[illegible] 020
24	Sunday	Destructors not working			
25		644			
26		745			
„ 27		791			
28		865			
„ 29		919			
„ 30		1 039	5 003	3 311	402 772
			18 796	11 638	2 132 2[illegible]

lb Refuse per unit generated—112 9 lb

Most units generated in one day 1 039 units

Highest load observed during month 472 Amperes at 235 volts 148 6 Electrical H P

Total units generated for 24 days 18 796

Average per day 783 units

Official Test

Date of Test	April 11 and 12, 1901
Duration of Test	22 hours
Number and type of Cells	6 Cells, single row, top fed
Total Grate Surface	180 square feet
Nature of Refuse	Unscreened, ashpit, house, trade and market
Number and type of boilers	1 Lancashire, 30 ft × 8 ft diameter
Total heating surface	About 1,000 square feet
Total quantity of Refuse burned	117,846 lb
Total quantity of Refuse burned per cell per 24 hours	21,424 lb
Total quantity of Refuse burned per cell per hour	892 lb
Total quantity of Refuse burned per sq ft of grate per hour	29 7 lb
Cost of Labour per ton burned	——
Total Water evaporated	135 624 lb
per hour	6 164 lb
per lb of Refuse burned at Feed Temp	1 15 lb
Total Water evaporated per lb of Refuse calculated from and at 212° F	1 39 lb
Total amount of Residual, Clinker ashpit dust flue dust	41,955 lb
Percentage of Residual to Refuse burned	35 5 per cent
Mean Steam Pressure	185 lb
Feed Temperature	50° F
, Main Flue Temperature	2 000° F
, Temperature behind boilers	500° F

Aldershot Urban District Council—Civil Population, 14,248.

S W

A	1901
B	Meldrum s front hand fed
C	4 Grates
D	2 Cornish 14 ft × 4 ft 3 in.
E	70 feet
F	Steam jet blowers
G	Sewage pumping
H	11 tons
I	1s 1d
Actual annual saving in coal cost	£300

This is one of the few installations in this country where Destructor cells have been adapted to existing boilers and chimney. The two Cornish boilers had been previously fired with coal for twenty years. Since the Destructor was erected no coal whatever has been used, and this in spite of the fact that in time of storm the normal flow (750,000 gallons) has been frequently trebled.

In addition to the saving in fuel cost, an additional economy has been effected by the utilization of the clinker on the bacteria beds, coke and coke breeze having previously been purchased for filtration purposes.

The total cost of the Destructor installation, including the necessary structural alterations involved, was about £1,200. The additional cost of burning refuse as compared with the labour cost for burning coal previous to the installation of the Destructor is given as 3½d. per ton of refuse destroyed.

ASHTON-UNDER-LYNE MUNICIPAL CORPORATION—POPULATION 43,890
J. W.

A	1901
B	Horsfall top fed
C	6
D	2 Multitubular
F	Steam Jet Blowers
G	Electric traction
H	30 tons
I	11 cc/

Four Lancashire boilers are also installed which are fired with coal alone, one of these boilers being always in use at the same time as the Destructor fired boilers.

A serious mistake was made in selecting multitubular boilers for a combined station of this character, and the experiment is not likely to be repeated. A common steam main being used for both the Destructor boilers and the coal fired boilers, it is therefore impossible to accurately determine the number of electrical units generated from the refuse, but Mr. Neville Appelbee, the

Electrical Engineer considers the combination of the Destructor with the electricity works to be serviceable

The power equipment comprises 3 Browett Lindley vertical compound engines and 2 Bellis engines the total H P being 2 000 with Sayers and Siemen's dynamos direct coupled having a total capacity of 1 200 K W

The following figures for the second year's working (1902) are interesting —

Load Factor	17 11 per cent
Fuel Cost	69 per unit
Works	1 18 " "
Total	1 48 " "
Net Profit	£278

ASTON MANOR MUNICIPAL CORPORATION—POPULATION 77 310

TWO INSTALLATIONS

	1	2
A	1892	1901
B	Fryer top fed	Sterling top fed
C	8	4
D	1 Multitubular	2 Babcock & Wilcox
F	165 feet	Same chimney used
I	Steam Jet Blowers	Fans
G	—	Works purposes generally, clinker crusher mortar mill lighting and engine
H		75 tons
I	11*d*	11*d*

ATHERTON URBAN DISTRICT COUNCIL—POPULATION 16 211

A	1902
B	Heenan back fed
C	2
D	1 Water Tube
F	90 feet
I	Fan
G	Supplied to an adjoining laundry
H	15 tons

BANGOR MUNICIPAL CORPORATION—POPULATION, 11,770

E W

A	1900
B	Meldrum s Beaman & Deas top fed
C	2
D	1 Hornsby Water Tube
E	80 feet
F	Fan
G	Electric lighting
H	Winter months — 8 tons Summer — 9 5
I	1s 4d
J	20

One Hornsby Water Tube boiler is also installed for supplementary coal firing as may be necessary Owing to the Destructor cells being erected after the boilers and generating plant had been installed it was not possible to place the Destructor in the most suitable position for securing the maximum benefit from the same for power production It is therefore not surprising to find that the average number of electrical units generated per ton of refuse destroyed is given as 20 only

The power equipment of the electricity works comprises 3 Willans engines the total H P being 450 these are direct coupled to dynamos of Messrs Fowler & Hall s make the total capacity of the same being 270 K W

BARRY URBAN DISTRICT COUNCIL—POPULATION 27 000

A	1901
B	Sterling top fed
C	2
D	1 Babcock & Wilcox—1 741 sq ft of heating surface
E	150 feet
F	Fan
G	Mortar mill fan engine works lighting
H	25 tons.
I	About 1s 3½d

The cost of Destructor and boiler was £2 763 chimney £1 805, the total cost, including buildings and site, being £8 541

Electrical Engineer, considers the combination of the Destructor with the electricity works to be serviceable

The power equipment comprises 3 Browett Lindley vertical compound engines and 2 Bellis engines, the total H P being 2 000 with Sayers and Siemen's dynamos direct coupled having a total capacity of 1 200 K W

The following figures for the second year's working (1902) are interesting —

Load Factor	17 11 per cent
Fuel Cost	69 per unit
Works	1 18 ,
Total	1 48
Net Profit	£278

ASTON MANOR MUNICIPAL CORPORATION—POPULATION 77 310

TWO INSTALLATIONS

	1	2
A	1892	1901
B	Fryer top fed	Sterling top fed
C	8	4
D	1 Multitubular	2 Babcock & Wilcox
F	165 feet	Same chimney used
F	Steam Jet Blowers	Fans
G	—	Works purposes generally clinker crusher mortar mill lighting and engine
H	75 tons	
I	11*d*	11*d*

ATHERTON URBAN DISTRICT COUNCIL—POPULATION 16 211

A	1902
B	Heenan back fed
C	2
D	1 Water Tube
E	90 feet
F	Fan
G	Supplied to an adjoining laundry
H	15 tons

BANGOR MUNICIPAL CORPORATION—POPULATION, 11,770

E W

A	1900
B	Meldrum's Beaman & Deas top fed
C	2
D	1 Hornsby Water Tube
E	80 feet
F	Fan
G	Electric lighting
H	Winter months – 8 tons Summer – 9 5
I	1s 4d
J	20

One Hornsby Water Tube boiler is also installed for supplementary coal firing as may be necessary Owing to the Destructor cells being erected after the boilers and generating plant had been installed it was not possible to place the Destructor in the most suitable position for securing the maximum benefit from the same for power production It is therefore not surprising to find that the average number of electrical units generated per ton of refuse destroyed is given as 20 only

The power equipment of the electricity works comprises 3 Willans engines the total H P being 450 these are direct coupled to dynamos of Messrs Fowler & Hall's make the total capacity of the same being 270 K W

BARRY URBAN DISTRICT COUNCIL—POPULATION 27 000

A	1901
B	Sterling top fed
C	2
D	1 Babcock & Wilcox—1 741 sq ft of heating surface
E	170 feet
F	Fan
G	Mortar mill fan engine works lighting
H	25 tons
I	About 1s 3½d

The cost of Destructor and boiler was £2 763 chimney £1 805 the total cost, including buildings and site, being £8,541

Barrow in Furness, Municipal Corporation—Population E W 57,586

A Destructor of the 'Heenan" back fed type is now in course of erection here comprising two twin cells and one Lancashire tube boiler The power will be fully utilized for electrical purposes

Bath Municipal Corporation—Population 49 821

A	1895 and 1899
B	Warner's top fed
C	10
D	1 Multitubular 14 ft × 8 ft
E	165 feet
F	Fan
G	Clinker crusher mortar mill and fan engine
H	15 tons
I	1s 3d

Originally a low temperature Destructor it was found necessary about two years since to apply forced draught to the cells and also to carry out other improvements, involving an expenditure of over £2 000 The original cost of the installation exclusive of site was £6 906

D	1 Babcock & Wilcox—1,426 sq ft of heating surface
E	120 feet × 5 ft 6 in, internal diameter
F	Steam Jet Blowers
G	Electric lighting
H	24 tons
I	1s 9d

Three additional coal fired Babcock & Wilcox boilers of similar capacity to that already mentioned are provided, and also a Green's Economiser The power equipment of the station comprises 2 200 H P, and 1,100 H P Bellis engines direct coupled to a 2 120 K W and 1 60 K W Fowler Alternators also one Browett Lindley engine direct coupled to a Johnson & Phillips Alternator of 250 K W capacity

As coal fired boilers are also used during the load, it has not been determined what power is actually produced from the combustion of the refuse Unfortunately the Destructor cells in this instance, as at Bangor, were not erected sufficiently close to the boilers to secure the best results in power production

Some details of an evaporative test carried out in September 1902, are here given—

Date of Test	September 19 and 20 1902
Duration of Test (started from cold)	18½ hours burning 16½ evap
Number and type of Cells	Three cell Single row back fed
Total Grate Surface	90 feet square
System of Forced Draught	Horsfall Co's Patent Steam Blower
Nature of Refuse	House, shop and market yard etc
Number of Firemen and average wage per day	Four at 5s
Number and type of Boilers	Two Water Tube
Total quantity of Refuse burned	25 tons 1 cwt 3 qrs 1 lb
Total quantity of Refuse burned per cell per 24 hours	10 tons 17 cwt
Total quantity of Refuse burned per square foot of grate per hour	34 lb
Total Water evaporated	28 tons 5 cwt 1 qr 8 lb
" " " per hour	1 ton 14 cwt 1 qr 1 lb = 3837 lb.

Total Water evaporated per square foot of heating surface per hour	1·34 lb
Total Water evaporated per lb of Refuse from and at 212° F or 100° C	1·512 lb
Mean Steam Pressure	145 lb
Feed Temperature (Tank)	57° F
Main Flue Temperature	1 700° F

A few extracts from the official figures of the first year's working (1902) are here given —

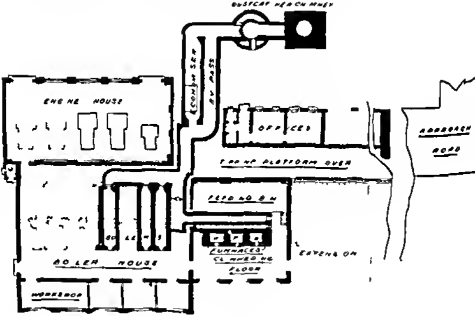

FIG 55 BECKENHAM COMBINED DESTRUCTOR AND ELECTRICITY WORKS Plan

Load factor	12·51 per cent
Fuel cost	·757d per unit
Works	2·451d ,,
Total	3·10d ,,
Deficit	£[illegible]

Fig 55 illustrates the general arrangement of this installation It will be observed that additional cells will be erected on the right and additional boilers on the left which arrangement must operate seriously against the general efficiency

Birkenhead Municipal Corporation—Population, 111,102
Two Installations

	1	2
A	1894	1896
B	Fryer top fed	Warner top fed
C	12	12
D	1 Multitubular 1 Babcock & Wilcox	1 Multitubular
E	180 feet	180 feet
F	Steam Jet Blowers	Fans
G	Mortar mills and forced draught	Mortar mills and forced draught
[1] H	90 tons	90 tons
I	10·21d	10·21d

Mortar sells freely at 6s 6d per ton and yields a fair profit The total expenditure in connection with the two installations, but exclusive of cost of the site, was £22 774

Birmingham Municipal Corporation—Population, 522 204
Four Installations [2]

	1 Shadwell Street	2 Montague Street	3 Rotton Park St	4 Montgomery St
A	1877	1879	1879	1899
B	Fryer top fed	Own design	Own design	Fryer Improved top fed
C	4	47		12
D	16 Multitubular and 2 Galloway			2 Lancashire
E	140 feet	260 feet	200 feet	195 feet
F	—	—	—	Fans
G	Screening and Poudrette shop	mixing manure plant mortar machinery	driving mills work	Electric lighting of works
H	Total 4000 Tons			
I	—	—	—	9·82d

[1] Twelve Cells only are in operation at one time

[2] Additional installations are now contemplated.

P

As will be observed, Birmingham is well equipped for the final and sanitary disposal of its refuse It is true that a large number of the cells in use do not conform to modern requirements, many having been in use for upwards of twenty years, but large modern installations are being erected as circumstances warrant, and doubtless in course of time the original cells, having served their purpose will be dismantled and replaced by modern cells

It is interesting to observe that during the year 1902, no less than 120 000 tons of refuse was destroyed, and that 5,805 tons of rough clinker and 4 806 tons of screened clinker were sold to contractors

BLACKBURN MUNICIPAL CORPORATION—POPULATION, 129,216

FOUR INSTALLATIONS

	1	2	3	4 W W
A	1879 1890 and 1900	1900	1901	1903
B	Fryer top fed	Meldrum's front hand fed	Heenan's back fed	Heenan's back fed
C	10	2 grates	6	8
D	1 Multitubular	1 Lancashire	2 Water tube	2 Lancashire
E	300 feet	75 feet	156 feet	150 feet
F	—	Steam Jet Blowers	Fan.	Fan
G	Mortar mills	Municipal workshops machinery	Supplied to gas works	Water pumping
H	40	15	30	45
I	10d	11d	10½d	—

The cost of installation No 2 was £1 200, as against £9,000 for No 3 installation, and a proportionally higher sum for installation No 4 The first installation cost £10 721

It should be noted that steam power is supplied to the Gas Works which adjoin Destructor No 1 For this steam the Gas

Committee pay a Scavenging Committee the sum of £300 per annum

Some interesting details of an evaporative test with this plant are here given —

Date of Test	May 15, 1901
Duration	7 hours 40 minutes
Cells in use	4—2 twin cells
Total grate area	120 square feet
Total heating surface of boiler	2,400 square feet
Type of boiler	Heenan's Patent Water Tube
Total Refuse burned	31 682 lb
Total Refuse burned per hour average	4,159 8 lb
Total Refuse burned per square foot grate per hour	34 66 lb

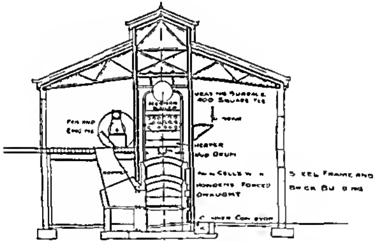

Fig [illegible] Blackburn (Greenbank) Destructor
Cross Section through Cells and Boiler

Refuse burned per cell per hour	1 015 lb or 9 cwt 0 qr
Rate of burning capacity per cell per 24 hours	10 tons 17 cwt 2 qr 0
Total clinker and fine ash	10 052 lb
Percentage of clinker and fine ash to charged refuse	25 5 per cent
Temperature of combustion chamber	1 800° F
Temperature at chimney base	700° F
Temperature of feed water in tank	59° F

Temperature of feed water after leaving exhaust steam heater	116 5° F
Temperature of charging floor	70° F
Temperature of clinkering floor	79° F
Average steam pressure	122 3 lb
Total water evaporated	36 221 lb
Total water evaporated per hour	4 724 7 lb
Total water evaporated per hour per square foot heating surface	1 96 lb
Total water evaporated per lb of refuse actual	1 135 lb
Total water evaporated per lb of refuse from and at 212° F	1 297 lb
Percentage of CO_2 (approximately)	11 87 per cent

Fig 56 is a cross section through the boiler, cells and hopper at No 3 installation which, however has been somewhat modified since

BLACKPOOL MUNICIPAL CORPORATION—POPULATION 50 330
FOUR INSTALLATIONS

E W

	No 1	No 2	No 3	No 4
A	1890	1896	1899	1903
B	Fryer top fed	Horsfall top fed	Mason's gasifier top fed	Horsfall's direct charged
C	8	4	2	6
D	1 Multitubular	1 Multitubular	1 Vertical	2 Babcock & Wilcox
E	—	116 feet	—	200 feet
F	—	Steam Jet Blowers	Steam Jet Blowers	Steam Jet Blowers
G	—	—	—	Electric Lighting
H	—	32 tons	8 tons	—
I	—	1s 6½d including supervision	—	—

With a population varying from 50 000 to 120 000 in the season ample destroying capacity is demanded and it will be observed

Temperature of feed water after leaving exhaust steam heater	116 8° F.
Temperature of charging floor	70° F.
Temperature of clinkering floor	79° F.
Average steam pressure	122 3 lb
Total water evaporated	36,221 lb.
Total water evaporated per hour	4,724 7 lb
Total water evaporated per hour per square foot heating surface	1 96 lb
Total water evaporated per lb of refuse actual	1 135 lb
Total water evaporated per lb of refuse from and at 212° F	1 297 lb
Percentage of CO_2 (approximately)	11 87 per cent.

Fig 56 is a cross section through the boiler, cells and hopper at No 3 installation, which, however, has been somewhat modified since

BLACKPOOL MUNICIPAL CORPORATION—POPULATION, 50 330
FOUR INSTALLATIONS

E W

	No 1	No 2	No 3	No 4
A	1890	1896	1899	1903
B	Fryer top fed	Horsfall top fed	Mason's gasifier top fed	Horsfall s direct charged
C	8	4	2	6
D	1 Multitubular	1 Multitubular	1 Vertical	2 Babcock & Wilcox
E	—	116 feet	—	200 feet
F	—	Steam Jet Blowers	Steam Jet Blowers	Steam Jet Blowers
G	—	—	—	Electric Lighting
H	—	32 tons	8 tons	—
I	—	1s 6½d includ ing supervision	—	—

With a population varying from 50,000 to 120,000 in the season ample destroying capacity is demanded, and it will be observed

that at Blackpool, with its many and varied attractions, sanitation has been kept carefully in mind

As showing the class of refuse which has to be dealt with during the season, it is interesting to note that no less than two tons of paper is collected every day within a half mile radius of the Town Hall. The fourth Destructor installation will undoubtedly prove to be very superior in every respect to those previously erected

BOLTON MUNICIPAL CORPORATION—POPULATION, 171 082
FOUR INSTALLATIONS

	No 1	No 2	No 3	No 4 New
A	1881	1888	1901	1902
B	Fryer top fed	Local design	Horsfall back hand fed	Meldrum Heenan & Froude top fed
C	8	10	8	8
D	1 Multitubular 1 Lancashire 30 ft × 7 ft	2 Multitubular 1 Lancashire 30 ft × 7 ft	2 Babcock & Wilcox	2 Babcock & Wilcox
E	180 feet	195 feet	Same chimney	220 feet
F	—	—	Steam Jet Blowers	Fan
G	Mortar Mills	Mortar Mills	Forced draught and Mortar Mills	Steam Pumping etc
H	40 tons	50 tons	59 tons	[illegible]
I	10*d*	10*d*	—	

Some details of an evaporative test with (No 3) Horsfall's Destructor at Wellington Yard are here given —

Date of test	August 2 1902
Duration of test	22½ hours
Number of cells used	8
Total grate area of cells	240 square feet.
Number and type of boilers used	2 Babcock & Wilcox,
Total heating surface of boilers	2 852 square feet.

Weight of Refuse destroyed per cell per hour	1,078 28 lb
Weight of Refuse destroyed per square foot of grate surface per hour	35 67 lb
Water evaporated per lb of Refuse from and at 212 F	8 lb
Mean Steam Pressure	116 5 lb
Highest temperature in main flue	2 000° F.
Percentage of residue to refuse destroyed	37 3 per cent

The general arrangement of Meldrum's Destructor (No 4) at Hacken Sewage Works will be seen by referring to the block plan (Fig 55) This is the most modern and complete installation in this country for dealing with Sewage Sludge

The sludge is pressed and so reduced to one fifth of its original bulk but when ready for destruction still contains sixty per cent of moisture Two thirds of sludge are destroyed to one third of refuse, and from this mixture sufficient power is obtained to operate the pumping plant sludge presses, lime mixers conveyor plant, and also for the electric lighting of the works and the manager's house 10 arc lamps and 44 incandescent lamps being provided for this purpose

Some interesting figures are available which will serve to clearly show how the two old Destructors in Bolton have been operated profitably as the result of the great demand for mortar produced from the clinker

The following statement for the year 1901, and referring to the old Destructors only, will doubtless be of interest

Total quantity of refuse destroyed—33,528¾ tons
Wellington Yard Destructor mortar making
Made and sold—

	£	s	d
[illegible] tons "Common" mortar at 5s per ton	1,837	10	0
[illegible] " "Special" " 6s 8d "	115	6	8
[illegible] "	£1,952	16	8
Cost of Mortar making	1,376	4	11
Balance	£576	11	0

Back o' The Bank Destructor, mortar making,
Made and sold—

	£	s	d
5,881 tons "Common mortar at 5s per ton	1,470	5	0
288¾ " "Special " " 6s 8d "	95	5	0
	1,565	10	0
Cost of mortar making	1,106	0	0
Balance	£459	0	0

SUMMARY

Total weight of mortar made and sold	13,865¾ tons		
	£	s	d
Total revenue from sales	3,518	6	8
Total cost of manufacture	2,482	4	11
Net profit from sales	1,037	11	9

The profit on the manufacture and sale of the mortar, according to the above figures, is such as to provide for the greater proportion of the labour cost in connection with the destruction of over 33,500 tons of refuse Nor are the results obtained during the year 1901 exceptionally good, for in 1897, after paying the wages cost, and also for lime and water, tools, and current repairs, the sales of mortar yielded a net profit of £1,360 0s 2d, which sum sufficed to pay the whole of the wages in connection with the Destructors while still leaving a balance of £120 15s 6d

Ten mortar mills are in constant use, the mortar is in great demand, and, as will be observed, at a paying figure While perhaps this case is without parallel, yet in every case where mortar is being made and sold a profit is being realized

BOOTLE MUNICIPAL CORPORATION—POPULATION, 58,566

A	1893
B	Local design, modified Fryer
C	12
D	1 Multitubular, 14ft × 8 ft
E	170 feet
F	—
G	Clinker crusher and mortar mills.
H	50 tons
I	11d

The total cost of this installation was £9,000 The clinker is fully utilized, a Musker Flag plant being installed in addition to the mortar mills

BOURNEMOUTH MUNICIPAL CORPORATION—POPULATION, 47,003

A	1887 and 1891
B	Warner's top fed
C	6
D	None used
E	150 feet
F	Natural draught only
G	No power available
H	30 tons
I	9*d*

This is one of the few remaining installations in this country working with natural draught alone Additional cells are badly needed, and these should be of the modern high temperature type

BRADFORD MUNICIPAL CORPORATION—POPULATION, 279,767

FOUR INSTALLATIONS

	No 1 Hammerton Street	No 2 Cliffe Road	No 3 Southfield Lane	No 4 E W Sunbridge Road
A	1897	1891	1902	1903
B	Horsfall top fed	Fryer top fed	Horsfall top fed	Horsfall top fed
C	12	8	6	12
D	2 Multitubular each 11 ft × 8 ft	—	—	2 Babcock & Wilcox, marine type
E	180 feet	180 feet	180 feet	—
F	Steam Jet Blowers	Steam Jet Blowers	Steam Jet Blowers	Steam Jet Blowers
G	Works purposes	Works purposes	Works purposes	Electricity
H	120 tons	—	—	120 tons
I	9*d*	—	—	—

Installation No 1, known as Hammerton Street Destructor, originally comprised a twelve cell plant of another make erected in 1880 and 1882 Nine years later forced draught was added to the twelve cells, which in 1897 were rebuilt by the Horsfall Company

This installation secured great prominence owing to the enterprise and unceasing labour of the late Mr John McTaggart, the well known Cleansing Superintendent of Bradford Mr McTaggart's work will be long remembered in Bradford tending as it did to revolutionize Refuse Disposal, more particularly perhaps in the economic utilization of the residuum

Some details of an evaporative test with this plant are here given —

Date of test	June 24 to July 7 1900
Number of cells	12
Type	Horsfall's back to back
Duration of test	278 hours
Nature of fuel	Midden, market and dry refuse
Number of men employed	12 furnace men, 6 chargers
Wages	Furnace men 28s, chargers 25s
Total quantity of refuse burned	2 896 320 lb = 1 293 tons
Total quantity of refuse burned per cell per 24 hours	20 837 lb = 9 3 tons
Total cubic feet of refuse burned per cell per 24 hours	543 feet
Total quantity of refuse burned per cell per hour	868 lb
Total quantity of refuse burned per square foot of fire grate per hour	34 lb
Cost of labour per ton destroyed	9d
Total weight of water evaporated	2 153 000 lb
Total weight of water evaporated per hour	7 774 lb
Total weight of water evaporated per cell per hour	645 lb
Water evaporated per lb of refuse burned	743 lb
Water evaporated per lb of refuse burned from and at 212 F	882 lb
Weight of clinker produced	817 516 lb = 364 96 tons
Weight of fine ash produced	26 936 lb = 12 02 tons

Weight of flue dust produced	5 992 lb =2 67 tons
Total weight of residuals	850,444 lb =379 65 tons
Percentage of residuals	29 35 *per cent*
Steam pressure maintained (by recorder)	60 lb
Temperature of feed water	60° F
Temperature of gases in main flue	1,800° F
Temperature of gases at chimney bottom	1,000° F
Average air pressure (water gauge)	$\frac{7}{8}$ in
Total I H P per hour at 20 lb	387 2
Total I H P per cell continuously	32 2
I H P hours per ton burned	83 2

SUMMARY OF WEIGHTS OF REFUSE TAKEN DURING TEST

	Tons	cwt	qrs
Left in pit to start with	15	0	0
1 358 loads of ashpit refuse	1,174	15	1
61 loads of market refuse	47	19	3
80 loads of light refuse	31	3	0
447 tradesmen's carts averaging 2 cwt each	44	2	0
	1 313	0	0
Less quantity left in pit	20	0	0
Total	1,293	0	0

	cwt	qr
Average weight of one load of ashpit refuse	17	1
Average weight of one load of market refuse	15	3
Average weight of one load of light refuse	7	3

	lb
One cubic foot of ashpit refuse weighs	42 2
One cubic foot of market refuse weighs	22 6
One cubic foot of light refuse weighs	19 2

During the test the power generated was utilized in the following manner

	£	*s*	*d*
306 tons 13 cwt 2 qr *of mortar made and sold* value	82	8	6
142 tons of crushed clinker sold	14	14	8
245 square yards of concrete flags manufactured value	38	15	10
3 tons 3 cwt 3 qr old tins sold value	0	15	11
About 4 tons of fish guano manufactured	12	0	0
	£148	14	11

The whole of the water evaporated was *measured* through a *Kennedy* water meter, fixed direct to the boiler

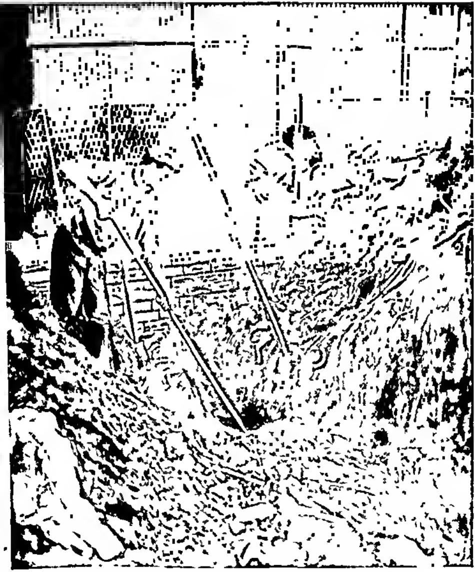

Fig. 78.—Baltimore (Hammerton Street) Destructor.

[illegible] Showing the Charging Operation.

Weight of flue dust produced	6 992 lb —2 67 tons
Total weight of residuals	850,444 lb —379 65 tons
Percentage of residuals	29 36 per cent
Steam pressure maintained (by recorder)	60 lb
Temperature of feed water	60° F
Temperature of gases in main flue	1 800° F
Temperature of gases at chimney bottom	1,000° F
Average air pressure (water gauge)	$\frac{7}{8}$ in
Total I H P per hour at 20 lb	387 2
Total I H P per cell continuously	32 2
I H P hours per ton burned	83 2

SUMMARY OF WEIGHTS OF REFUSE TAKEN DURING TEST

	Tons	cwt	qrs
Left in pit to start with	15	0	0
1 358 loads of ashpit refuse	1,174	15	1
61 loads of market refuse	47	19	3
80 loads of light refuse	31	3	0
447 tradesmen s carts averaging 2 cwt each	44	2	0
	1 313	0	0
Less quantity left in pit	20	0	0
Total	1,293	0	0

	cwt	qr
Average weight of one load of ashpit refuse	17	1
Average weight of one load of market refuse	15	3
Average weight of one load of light refuse	7	3

	lb
One cubic foot of ashpit refuse weighs	42 2
One cubic foot of market refuse weighs	22 6
One cubic foot of light refuse weighs	19 2

During the test the power generated was utilized in the following manner

	£	s	d
306 tons 13 cwt 2 qr of mortar made and sold value	82	8	6
442 tons of crushed clinker sold	14	14	8
215 square yards of concrete flags manufactured value	38	15	10
3 tons 3 cwt 3 qr old tins sold value	0	15	11
About 1 tons of fish guano manufactured	12	0	0
	£148	14	11

The whole of the water evaporated was measured through a Kennedy water meter, fixed direct to the boiler

Bridport Municipal Corporation—Population, 5 944

The Council have recently decided to erect a small Destructor of the Horsfall type

Brighton Municipal Corporation—Population, 124 539

A	18[illegible]
B	Fryer Improved, including [illegible] & Brodie [illegible]
C	12
D	1 Mild steel [illegible] 1[illegible] f[illegible]
E	[illegible] feet
F	Fan
G	Mortar mill and fan engine
H	72 tons
I	1s [illegible] per ton

The Destructor was originally arranged to work with natural draught but about two years since it was found advisable to add forced draught at a cost of about £1 791

The mortar made from three parts of clinker to one part of lime is disposed of at a small profit A considerable quantity of clinker is used for road foundations and to further utilize the product it is proposed to erect a clinker brickmaking plant Exhaustive inquiries concerning the utilization of clinker for brickmaking were made both in this country and on the Continent

Bristol Municipal Corporation—Population, 328 842

A	18[illegible]
B	Fryer [illegible]
C	10
D	1 [illegible] 12[illegible]
E	1[illegible] feet
F	Steam jet [illegible] Natural draught [illegible]
G	Forced draught, mortar mill, etc
H	[illegible] tons
I	11[illegible] per ton

[illegible]1

ANALYSES OF CHIMNEY GASES FROM HAMMERTON STREET DESTRUCTOR, BRADFORD, BY MR F W. RICHARDSON, F I C, F C S, CITY ANALYST OF BRADFORD

Date	1 June 29	2 July 24	3 August 3, 1900
Carbon dioxide	4 62	6 12	3 82 per cent
Carbon monoxide	1 88	none	3 78 ,, ,,
Sulphur oxides	—	traces	none
Oxygen	14 68	15 40	16 40 ,, ,,
Nitrogen	78 82	78 48	76 00 ,, ,,

At installation No 3 (Southfield Lane) a considerable quantity of screened clinker and mortar is sold, as is also the case at Hammerton Street (No 1), and at the latter works a flag plant is also in operation, which is capable of turning out some 200 paving flags per day

At installation No 4 (Sunbridge Road) the twelve cell plant is just now in course of erection, and will replace nine old cells The power will be fully utilized for generating electricity, the makers guaranteeing an output of 1,000,000 units per annum from 120 tons of refuse daily Assuming that the working days number 300 this would give an output per ton of refuse destroyed of rather less than 28 units, which figure should be reached without difficulty

Fig 58 clearly shows the method of charging at the No. 1 Hammerton Street Destructor, top fed type; the intake to the blast flue will be observed immediately behind the chargeman

BRENTFORD URBAN DISTRICT COUNCIL—POPULATION, 15,163
S W

A . . .	1900.
B .	Fryer's improved, with Messrs Boulnois, Wood & Brodie's patents
C . .	4.
D . .	2 Babcock & Wilcox.
E .	150 feet.
F . .	Fan
G . .	Sewage pumping, 600,000 gallons per 24 hours also electric lighting of the works, stables and yard
H . .	14 tons

BRIDPORT MUNICIPAL CORPORATION—POPULATION, 5,944

The Council have recently decided to erect a small Destructor of the Horsfall type

BRIGHTON MUNICIPAL CORPORATION—POPULATION, 124,539

A	1896
B	Fryer s Improved, including Messrs Boulnois & Brodie s patents
C	12
D	1 Multitubular, 12 ft × 8 ft
E	200 feet
F	Fan
G	Mortar mill and fan engine
H	72 tons
I	1s 7d per ton

This Destructor was originally arranged to work with natural draught, but about two years since it was found advisable to add forced draught at a cost of about £1 791

The mortar, made from three parts of clinker to one part of lime is disposed of at a small profit A considerable quantity of clinker is used for road foundations and to further utilize this product it is proposed to erect a clinker brickmaking plant Exhaustive inquiries concerning the utilization of clinker for brickmaking were made both in this country and on the Continent

BRISTOL MUNICIPAL CORPORATION—POPULATION, 328,842

A	1892
B	Fryer top fed
C	16
D	1 Multitubular 12 ft × 8 ft
E	180 feet
F	Steam jet blowers —8 cells Natural draught —8 cells
G	Forced draught mortar mills, etc
H	108 tons
I	11½d per ton.

The cost of the Destructor installation was as follows —

	£
Foundations	2,909
Destructor, cremator, approach road and offices	6,820
Chimney	1,689

A clinker crusher and two mortar mills with 7 ft pans are installed to deal with part of the clinker, also a Musker Flag plant. During the year ending March 25, 1902, the clinker was disposed of as follows —

14	tons of mortar sold at 7s 6d per ton
1,777	used by the Corporation
2,635	screened ashes sold at 1s 8d per ton
28	used by the Corporation
343	rough ashes sold at 1s per ton
170	breeze sold at 1s 3d per ton
145	used by the Corporation
849	clinker for road foundations sold at 1s per ton
1,324	used by the Corporation
2,239	carted to tips
1,053	used for concrete flags and artificial stone dressing

About 97 yards super of paving flags are produced daily in 9 hours at a cost of 2s 6d per yard, exclusive of repairs and depreciation. Slabs and building dressings are also made in wooden moulds by hand at a cost of 2s 1d per yard super.

BURNLEY MUNICIPAL CORPORATION—POPULATION, 97,04[illegible]

TWO INSTALLATIONS

	1	2 (E W)
A	1888	1902
B	Meldrum's [illegible] Destructor, top fed	Meldrum's front hand fed
C	1 Babcock & Wilcox	1 Lancashire, 30 ft × 8 ft
D	2	4 grates
F	Fan	Steam jet blower
G	Electric lighting	Electric lighting
H	30 tons	40 tons

In addition to the boilers in connection with the Destructors, 3 Lancashire boilers each 28 feet long and 7 feet 0 inches in diameter, are installed for coal firing. The power equipment of the station is as follows:—5 compound condensing engines, with 5 Elwell Parker and E C C dynamos direct coupled, having a total capacity of 960 K W; also Tudor cells of 500 ampère hours capacity.

[1] BURSLEM MUNICIPAL CORPORATION—POPULATION 38,700

A	1880
B	Fryer's top fed
C	1
D	1 Multitubular
E	80 feet
F	Fan
G	Fan engine only
H	25 tons
I	1s 5d

BURTON ON TRENT MUNICIPAL CORPORATION POPULATION, 50,386

TWO INSTALLATIONS

	1	2
A	1901	1899
B	Fryer top fed	Meldrum front hand fed
C	4	2 grates
D	1 Multitubular	1 Cornish 20 ft × 6 ft
E	144 feet	Same chimney used
F	—	Steam Jet Blowers
G	Works purposes only	Lighting works, water pumping, clinker crushing
H	25 tons	20 tons
I	1s 4d per ton	1s 4d per ton

The installation here is of peculiar interest, the accompanying report by Mr G T Lynam, the Borough Engineer, will serve to show how the Fume Cremator was "converted" into a two grate unit Destructor, a novel departure, but apparently amply justified by the results obtained.

[1] It has recently been decided to erect a second Destructor to deal with 10,000 tons of refuse per annum. The power will be fully utilised for electrical purposes.

County Borough of Burton-on-Trent

Corporation Destructor

The first portion of the Destructor, consisting of four cells, tipping platform approach road, boiler and engine room, sheds and chimney, were erected by Messrs Manlove, Alliott & Co, in 1890, at a cost of £4,800

These cells are capable of destroying about 8,600 tons of refuse per annum The quantity of clinker and ash remaining is about one third of the bulk put into the furnaces

About a year and a half ago a new furnace was erected by Messrs Meldrum Bros, and the following is an epitome of the tests which were completed in April, 1900 *It was feared that with forced draught to the new cells, the efficiency of the old ones would be seriously interfered with*, but as a matter of fact, the loss was not very great after certain difficulties as to the arrangement of the flue dampers were overcome

At the first test, with the ordinary staff of men working 16 hours on the new furnace and twenty four hours on the old, the former destroyed 15 tons 4 cwt 3 qrs, or 19 cwt per hour. The four old cells destroyed 27 tons 11 cwt 1 qr, or nearly 23 cwt per hour

At the second test, which lasted 24 hours, the Meldrum cells destroyed 25 tons 8 cwt or 21 cwt per hour, which is equal to 44 8 lb of refuse destroyed per square foot of grate area per hour At the same time, the old cells destroyed 23 tons 15 cwt 3 qrs, or 19 cwt 3 qrs 8 lb per hour equal to 22 2 lb per square foot per hour For this test four additional men were employed

A third test made with the new furnace working to its full capacity resulted in 131 tons 14 cwt being consumed in 120 hours, or 21 9/10 cwt. per hour equal to 44 5 lb of refuse per square foot of grate surface, the proportion of clinker resulting being 25 5 per cent.

As Messrs Meldrum's guarantee was to destroy not less than 15 tons of refuse per 24 hours, the result of the test shows that they have exceeded that amount by 75 5 per cent.

A new Cornish boiler, 20 feet by 6 feet, has been fixed, the old one having proved to be much too small to deal with the great heat now produced

It is proposed now to add to the works an electrical installation for lighting the stables and workshops adjoining, and a plant for pumping water for washing night soil pans. A stone breaker for breaking clinker and other material has recently been fixed If further use can be found for the steam, there is little doubt that there is sufficient heat for a second boiler of the size above stated

The total cost of the addition of the Meldrum furnace, with alteration to flues, new bye-pass, and the incidental work in connection with the alterations, has been about £740

The following facts will be of interest, but they relate only to the old cells:—

	£	s	d
Total cost of working for 12 months ending March 31, 1900 was equal to 2s 1d per ton burned	930	7	5
Wages for same period were equal to 1s 5½d per ton burned	645	4	7
Repairs to machinery	9	13	8
firebars	20	0	10
buildings	70	3	0

The weight of the refuse consumed at present is about 200 tons per week and the average amount of wages is £13 19s, equal to 1s 4d per ton. The number of men employed is 8 divided into 2 day shifts of 3 men each and a night shift of 2 men when the Meldrum furnaces are not used.

GEORGE T LYNAM
Borough Engineer and Surveyor

TOWN HALL June 13 1901

BURY MUNICIPAL CORPORATION—POPULATION 58 028

TWO INSTALLATIONS

S W

	1	2
A	1897	1901
B	Warner top fed	Horsfall top fed
C	[illegible]	[illegible]
D	3 Multitubular	2 Babcock & Wilcox
E	180 feet	—
F	Fan	Steam jet blowers
G	Works purposes	Sewage pumping
H		40 tons
I		10 8d

A few details of an evaporative test made by Mr Watson, the Electrical Engineer are here given —

Duration of test	4 hours.
Number of cells in use	6.
Total refuse destroyed	9 tons 1 cwt.
water evaporated per hour	2 700 lb
Temperature of feed water	50° F
Evaporation per lb. of refuse	·532 lb.

Complete details of a test with installation No 2 are here given —

Date of test	March 10 to 11, 1902
Duration of test	24 hours
Number and type of cells	6 Horsfall cells, back to back
Total grate surface	180 square feet
Nature of refuse	Unscreened house wet ashpit, garden and market
Number and type of boilers	2 Babcock & Wilcox.
Total heating surface	2,852 square feet
Total quantity of refuse burned	129,360 lb
Total quantity of refuse burned per cell per 24 hours	21,560 lb
Total quantity of refuse burned per cell per hour	898 lb
Total quantity of refuse burned per square foot of grate per hour	29.9 lb
Tons per man per watch	5 tons 15 cwt
Cost of labour per ton burned	10.8*d*
Total water evaporated	98,728 lb.
Total water evaporated per lb of refuse calculated from and at 212° F	94 lb
Total water evaporated per square foot of heating surface per hour	1.4 lb
Mean steam pressure	121.8 lb
Mean feed temperature	50° F
Mean main flue temperature	1,800° F
Mean temperature behind boilers	500° F

Buxton Municipal Corporation—Population, 10,181

S W

A	1891
B	Fryer top fed.
C	4
D	—
E	150 feet
F	—
G	No power available.
H	12 tons
I	11*d*

Cambridge Municipal Corporation—Population, 38,398

A	189[illegible]
B	Fryer's improved including Messrs. Boulnois, Wood & Brodie's patents top fed

C	6
D	3 Babcock & Wilcox
L	175 feet

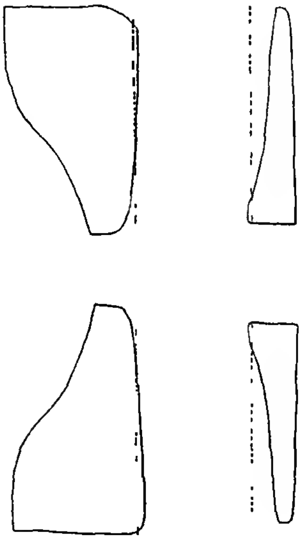

FIG. 79. INDICATOR DIAGRAMS CAMBRIDGE COMBINED DESTRUCTOR AND SEWAGE WORKS

F	Fan.
G	Sewage pumping.
H	35 tons.
I	1s. 3d. including supervision

The total cost of the Destructor, boilers, building and chimney was £10 177. The dry weather flow of sewage is 2 000 000 gallons, this volume having to be lifted 43 feet. The pumping plant comprises two 80 H P tandem compound condensing pumping engines.

The indicator diagrams here reproduced (see Fig 59) are very interesting as showing what work has been accomplished

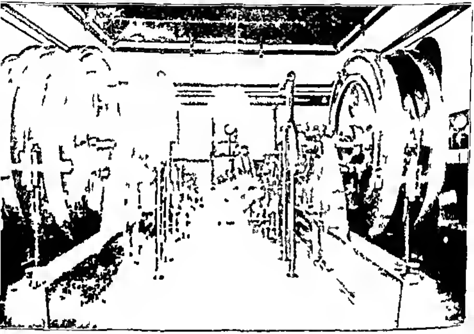

FIG. [illegible] Compound Condensing Pumping Engines, Cambridge Combined Destructor and Sewage Works

with this plant, while Figs 60 and 61 respectively clearly show the pumping engines and cells and boilers.

The calculations of power (see Fig 59) are as follows—

Diameter of cylinders [illegible] in, 48 in	Stroke 4 ft
Steam on boiler	78 lb
Vacuum	[illegible] in
Strokes per minute	[illegible]
Mean P in H P cylinder	77 2 lb
L P	7 [illegible]
I H P in H P	99 38 } = 140 78 I H P
I H P in L P	41 4 }

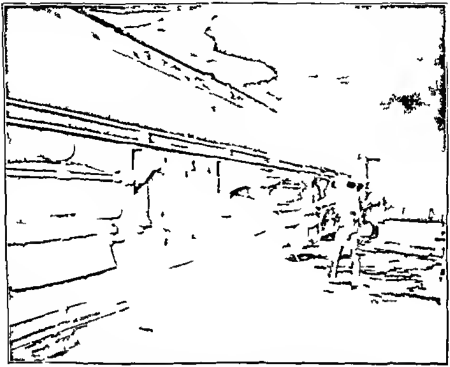

FIG 61 DPSTRUCTOR CPLLS AND BOILPRS CAMBRIDGE COMBINED DESTRUCTOR AND SF AGE WORKS

CANTERBURY MUNICIPAL CORPORATION—POPULATION 24 868

E W

A	1899
B	Mel lru ss Beaman & Deas top fed
C	2
D	1 Babcock & Wilcox
F	150 feet
I	Fan
G	Electr c l gl t ng
H	20 tons
	s d
I	1 986

Four Lancashire boilers for supplementary coal firing are provided in a separate boiler house and the power equ pment of the station is as follows —4 high speed enclo ed engines and 4 dyna mos direct coupled of a total capacity of 600 K W Also 280 Chloride R type cells capacity 630 ampere hours

Some details of the official evaporative test of the Destructor are here given

Official test at Canterbury Destructor and Electricity Works with Meldrum's Beaman and Deas Patent Destructor

Quality of refuse	*Dry and of average quality*
Duration of test	8¾ hours
Average temperature of feed water	123° F
Average boiler pressure	125 lb per square inch
Refuse consumed	29 400 lb
Water evaporated	41 300 lb
Water evaporated per lb of refuse under actual conditions	1 4 lb
Water evaporated per lb of refuse from and at 212° F	1 [illegible]8 lb
Water evaporated per lb of refuse from feed water at 60° F	1 28 lb
Refuse burned per hour	3 360 lb
Water evaporated per hour	4 717 lb
Rate of burning per day of 12 hours	18 tons
Weight of clinker	5 tons 3 cwt

It is interesting to compare the figures of the official test with the following figures which cover a period of 200 working hours —

Total weight of refuse destroyed	2[illegible]6 tons
Average rate of combustion per hour	1 28 tons
Total water evaporated (actual)	[illegible]2 480 lb
Average evaporation per lb of refuse destroyed (actual)	[illegible]980 lb
Average evaporation per hour	2 762 lb

Cheltenham Municipal Corporation—Population, 49 4[illegible]9

A	18[illegible]0
B	[illegible] top fed
C	8
D	1 Multitubular
E	100 feet
F	—
G	Mortar mills and disinfector
H	40 tons
I	7 [illegible]

CHESTERFIELD—POPULATION, 27,185 S W

A	1901 and 1902
B	Horsfall back hand fed
C	4
D	2 Babcock & Wilcox
E	—
F	Steam jet blowers
G	Sewage pumping
H	25 tons
I	7 6d

This installation has been very successful The clinker is crushed and utilized on the Bacteria Beds

CLECKHEATON URBAN DISTRICT COUNCIL—POPULATION, 15 250 E W

A	1902
B	Meldrum front hand fed
C	4 grates
D	2 Lancashire each 26 ft × 7 ft 6 in
E	120 feet
F	Steam jet blowers
G	Electric traction
H	12 tons
I	—
J	35

The working pressure of the boilers is 180 lb steam being supplied to the engines at 160 lb pressure In addition to regenerators for heating the air supply for combustion a Green's Economiser of 192 pipes is also provided

The equipment of the power station is as follows —

3 Bellis high speed engines, and 3 Johnson Lundell dynamos direct coupled having a total capacity of 450 K W, also 270 E P S cells—capacity 400 ampere hours

The main load at present is for traction purposes, the Council having an agreement with the British Electric Traction Company, by which all energy required will be supplied from the Council's station

The agreement provides for a minimum supply of 400 000 units

per annum at 1½d. per unit, that is the Company will pay £2,500 per year to the Urban District Council. The next 100,000 units will be charged at 1¼d. per unit, and all in excess of this at 1⅛d. per unit. This is generally considered by all concerned to be a fair price, enabling all standing station charges to be met, but giving no undue profit to the Council. Briefly, such an agreement allows Cleckheaton to possess its own electricity undertaking without risk of its being any burden on the rates.

COLNE MUNICIPAL CORPORATION—POPULATION 23,000.

E. W.

A	1899
B	Meldrum's Bowman C.D. as top fed
C	2
D	1 Babcock & Wilcox
E	240 ft. × 6 ft., internal throughout
F	Fan
G	Electric lighting
H	18 hours
I	10½d.
J	20

The following report by Mr. H. C. Sugden, the Health Superintendent, of the first nine months' working of this installation will doubtless be of interest:

REFUSE DESTRUCTOR.

This important undertaking commenced working in March last, and for the nine months ending December 31, 1899, it burnt the following refuse:—

Loads of refuse	1,759		
Loads of garbage	43		
Total	1,802		
	Tons	cwt.	qrs.
Weight of ashes	1081	1	22
Weight of garbage	10	18	0
Total	1132	10	2

The number of actual working fan hours of the furnaces amounts to 1,767, showing a consumption of refuse amounting to 1 ton 15 cwt 1 qr. per two cells per hour This in my opinion, is a very good result, when we take into consideration that in summer we only average 57 tons per week of 48 fan hours while in the winter our consumption amounts to an average of 98 tons per week of 48 fan hours

There is no doubt that if there were sufficient refuse in the town to keep the Destructor working night and day the consumption would be materially increased as the furnaces in the morning are practically cool, thus necessitating the first few loads taking longer to burn than those at a later period of the day

I should like to draw your attention to the enormous waste of steam, which could undoubtedly be used for some purposes to create a slight revenue

On January 26 1909, Mr Cooper the electrical engineer, and I took a test to gauge the amount of horse power which at present is not utilized for any purpose

Duration of test	9½ hours
Steam pressure	90 lb
Temperature of feed water	100° F
Water evaporated	17 tons 1 cwt 3 qr or 38,276 lb
Water evaporated per lb of refuse burned	1 lb of water
Horse power on a basis of 20 lb steam per I H P	203 H P per hour

The test, in comparison with sixteen Destructors in various parts of the country, shows exceedingly well, and, as I said before, if the furnace did not cool during the night more favourable results would be acquired Comparing the work of the last few months, I find that it is now being done with greater economy and despatch The men have now got quite used to their work, and appear to be content

Considering the financial side of the Destructor, the cost of burning runs out somewhat as follows —

	s	d	
Cost of burning (labour only)	0	10½	per ton
Sinking fund and interest	1	1	„ „
Cost of carting, office, etc .	2	1	„ „
This makes a total cost of refuse burned .			„ „

The cost of the installation was as follows

	£	s	d
Land and ground rent	2 000	0	0
Chimney	2 025	0	0
Buildings	1 450	0	0
Approach road	1,110	0	0
Destructor and boiler	1 190	0	0
Office and weighbridge	400	0	0
Engine and mess room	500	0	0
Boundary wall	450	0	0
Clinker crushing plant and engine	450	0	0
	£9 675	0	0

Wishing to fully utilize the power available from the Destructor it was decided to instal a Parson s turbine and steam is now supplied to a 150 H P Parson s Turbo Generator which generates at 480 volts for lighting and 500 to 550 volts for traction It is run at 3 300 revolutions

The additional plant at the electricity works is as follows One Lancashire boiler and Green s economiser, one Bellis engine direct coupled to a Greenwood and Batley s multipolar dynamo the total capacity being 260 K W also 270 P T L York cells capacity 60 ampere hours

The clinker from the Destructor is crushed and graded a portion being utilized for mortar making but the greater part is sent to the sewage works for use on the bacteria beds instead of coke, which was formerly employed

CROYDON—POPULATION, 137,000

The Corporation have recently decided to erect a Destructor of the Warner Perfectus" type on a site known as Brimstone Barn

It is also proposed to erect two other Destructors in the immediate future on other sites, with a view to keeping the cartage cost as low as possible

DARTFORD URBAN DISTRICT COUNCIL—POPULATION, 18 643

E W & S W

A	1903
B	Meldrum improved top fed
C	2 grates
D	1 Lancashire 30 ft × 8 ft
I	120 feet
I	Steam jet blowers

G	Electric lighting and sewage pumping
H	20 tons
I	Not yet determined the Destructor only having recently been started

A Sugden Superheater is set in the downtake at the back of the boiler to give a moderate superheat while beyond the superheater is the regenerator for heating the air for combustion, and also a Green's Economiser for heating the boiler feed water A Bruun Lowener Water Softener is also installed and arranged to deliver a supply of hot water to the economiser

The power will be fully utilized for sewage pumping and electric lighting and it is anticipated that the daily collection of refuse will give sufficient steam not only for the operation of the sewage pumps, but also for the electric lighting until the demand for current seriously increases

Two additional Lancashire boilers of the same size as the Destructor boiler are installed in a separate boiler house and these will be coal fired as may be found necessary The power equipment of the electricity works comprises two Reavell engines, direct coupled to two General Electric Company's dynamos the total capacity being 250 K W A storage battery has been installed by Messrs Ashmore, Benson Pease & Co , and has a capacity of 250 ampere hours

DARWEN MUNICIPAL CORPORATION—POPULATION, 40,000

E W

A	1899
B	Meldrum front hand fed
C	8 grates
D	2 Lancashire each 30 ft × 8 ft
E	240 feet
F	Steam jet blowers
G	Electric traction and lighting
H	35 tons.
I	Is
J	33

For the year ending March 31, 1901, the following interesting figures are available The average evaporation per pound of

refuse destroyed over a total quantity of 10,000 tons was actually 1 25 lb of water During the same period the total cost of coal water and stoking to the Electricity Department was £1 200 With their separate coal fired boilers the Electricity Department evaporated 2 940,000 gallons of water during the year, while the boilers in connection with the Destructor, from refuse alone, evaporated 2 520 000 gallons of water during the same period, this being a *net* quantity after deducting the proportion of steam supplied for the forced draught blowers

On the basis of £1 200 as the cost of evaporating 2 940 000 gallons of water with the coal fired boilers, the 2,520,000 gallons of water evaporated by the Destructor boilers has a value of £1 050 that is, had there been no available power from the refuse the Electricity Department would have paid £1,050 extra for water coal and labour charges, so that clearly this amount in the gross, was saved by the combination

The figures quoted are reliable, the water being supplied to the electricity works and the Destructor works through separate meters Two supplementary coal fired boilers are provided in a separate boiler house The power equipment is as follows —Four Bellis engines and two Siemens', one Mather and Platt and one Bruce Peebles dynamos, direct coupled, having a total capacity of 900 K W Also 250 Tudor cells of 600 ampere hours' capacity, maximum discharge 250 ampères

Some extracts from the returns for the second year's working are of interest —

Load factor	12 12 per cent
Fuel cost	65*d* per unit
Works ,,	1 10*d* ,, ,,
Total ,,	1 31*d* ,, ,,
Net profit	£217.

Some details of an evaporative test with the Destructor are here given —

Date of test	April 5, 1900
Duration of test (2 p m. to 10 p m) .	8 hours

Kind of fuel burned	Unscreened ashpit refuse
Total refuse burned (15 tons 15 cwt.)	35,280 lb.
Refuse burned per hour (1 ton 19 cwt. 1 qr. 14 lb.)	4,410 lb.
Refuse burned per square foot of grate per hour	52.5 lb.
Total water evaporated (4,903.5 gallons)	49,035 lb.
Water evaporated per hour (612.94 gallons)	6,129.4 lb.
Water evaporated per lb. of refuse, actual	1.39 lb.

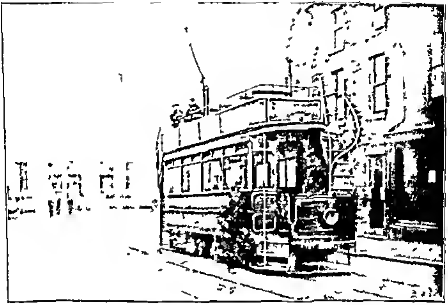

FIG. 62. DARWEN COMBINED DESTRUCTOR AND ELECTRICITY WORKS ELECTRIC CAR

Water evaporated per lb. of refuse, from and at 212° F. . . .	1.71 lb.
Total weight of clinker and ash (4 tons 17 cwt. 2 qrs. 16 lb.) . .	10,936 lb.
Percentage of clinker and ash .	31 per cent.
Average steam pressure . . .	195 lb.
Temperature of feed water . . .	40° F.
Temperature of hot air feed . . .	291.6° F.
Temperature in combustion chamber (by copper test)	2,000° F.

ANALYSIS OF FLUE GASES.

Percentage of carbonic acid (CO_2) (36 readings)	14 13 per cent.
Percentage of free oxygen (O) (35 readings)	6 21 per cent.
Percentage of carbonic oxide (CO) (35 readings)	*Nil.*

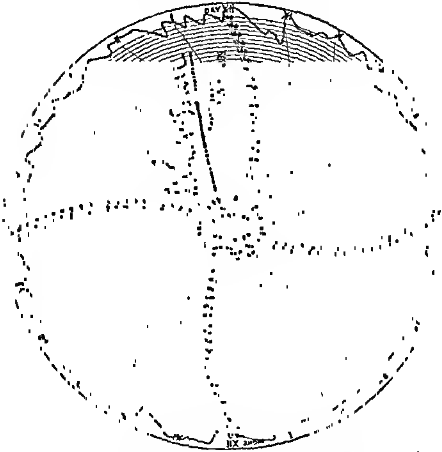

FIG. 63 DARWEN COMBINED DESTRUCTOR AND ELECTRICITY WORKS STEAM PRESSURE RECORDER DIAGRAM.

Fig. 62 shows one of the electric cars which are in operation for 18 hours daily between Darwen and Blackburn, the current being generated by steam from the Destructor boilers It will be interesting to the still doubting councillor to compare this illus-

tration with say Figs 2 3 5 and 6 Fig 63 is a reproduction of a steam pressure recorder diagram

DERBY MUNICIPAL CORPORATION—POPULATION, 113 863
TWO INSTALLATIONS

	1	2
A	1889	1898
B	Fryer top fed	Warner top fed
C	6	6
D	—	1 Multitubular 10 ft × 6 ft
E	160 feet	Same chimney used
F	—	Fan
G	—	Fan engine and elevator
H	50 Tons	—
I	—	—

DEWSBURY MUNICIPAL CORPORATION—POPULATION, 28 060

A	1898
B	Meldrum s Beaman & Deas top fed
C	2
D	1 Babcock & Wilcox
E	90 feet
F	Fan
G	Fan engine and mortar mill
H	28 tons
I	13 75*d*

A considerable quantity of mortar is made, which sells freely at 7*s* per ton yielding a fair profit

EALING MUNICIPAL CORPORATION—POPULATION, 33 010
S W

A	1883 Three extensions since
B	Fryer Warner and Ealing model all top fed
C	10
D	3 Multitubular
E	143 feet
F	Fan
G	Sewage pumping sludge pressing etc, for approximate details see below [1]
I	—

Estimated saving in coal cost per annum £300

ANALYSIS OF FLUE GASES.

Percentage of carbonic acid (CO_2) (35 readings)	14 13 per cent.
Percentage of free oxygen (O) (35 readings)	6 21 per cent.
Percentage of carbonic oxide (CO) (35 readings)	*Nil.*

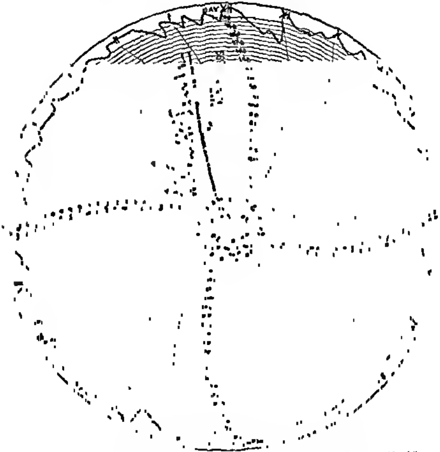

FIG. 63 DARWEN COMBINED DESTRUCTOR AND ELECTRICITY WORKS STEAM PRESSURE RECORDER DIAGRAM.

Fig. 62 shows one of the electric cars which are in operation for 18 hours daily between Darwen and Blackburn, the current being generated by steam from the Destructor boilers. It will be interesting to the still doubting councillor to compare this illus-

tration with say Figs 2 3 5 and 6 Fig 63 is a reproduction of a steam pressure recorder diagram

DERBY MUNICIPAL CORPORATION—POPULATION, 113 863
TWO INSTALLATIONS

	1	2
A	1882	1898
B	Fryer top fed	Warner top fed
C	6	6
D	—	1 Multitubular, 10 ft × 6 ft
E	160 feet	Same chimney used
F	—	Fan
G	—	Fan engine and elevator
H	50 Tons	—
I	—	—

DEWSBURY MUNICIPAL CORPORATION—POPULATION, 28 060

A	1898
B	Meldrum s Beaman & Deas top fed
C	2
D	1 Babcock & Wilcox
E	90 feet
F	Fan
G	Fan engine and mortar mill
H	28 tons
I	13 75*d*

A considerable quantity of mortar is made, which sells freely at 7*s* per ton yielding a fair profit

EALING MUNICIPAL CORPORATION—POPULATION 33 040
S W

A	*1883 Three extensions since*
B	Fryer Warner and Ealing model all top fed
C	10
D	3 Multitubular
E	143 feet
F	Fan
G	Sewage pumping sludge pressing etc for approximate details see below [1]
I	—

Estimated saving in coal cost per annum £300

Mr Chas Jones M.I.C.E., the Surveyor, has done yeoman service for many years past in popularizing the Refuse Destructor and his name will always be remembered and honoured by the sanitarian.

The clinker is all fully utilized. Mr Jones has always claimed that he could make good use of every pound of clinker.

[1] Air compressors for sludge pressing	2[illegible] H.P.
Forced draught	14
Sludge pump and slab plant	8
Engines for operating lime mixers and agitators in tanks	12
3 steam pumps aggregating	[illegible]0
Total	70 H.P.

EASTBOURNE MUNICIPAL CORPORATION—POPULATION, 43 337
S. W.

A	1890
B	Fryer top fed
C	6
D	2 Multitubular
E	150 feet
F	Natural draught only
G	—
H	35 tons
I	—

A six cell modern Destructor of the improved Fryer type is now in course of erection with three Babcock and Wilcox boilers, one boiler being set between each pair of cells. The power will be fully utilized for working the air compressing plant in connection with Shone's ejectors. This Destructor will displace the original plant as described above, but the same chimney will be used.

EAST HAM URBAN DISTRICT COUNCIL—POPULATION, 100 000
S. W.

A	1901
B	Meldrum's special type front hand fed
C	2

[1] A considerable quantity of sludge is destroyed with the refuse.

D	1 Babcock & Wilcox
E	—
F	Steam jet blowers
G	Sewage pumping
H	—
I	—

This plant is now in course of erection it is merely an experimental installation preliminary to the erection of a complete Destructor plant

Refuse will be burned in special designed furnaces installed under a large Babcock and Wilcox boiler and also in connection with a large Lancashire boiler This course has been decided upon as the result of some experiments carried out on similar lines with East Ham refuse a few months since

While undoubtedly a considerable amount of power may be obtained the system cannot be generally recommended mainly because power production and not perfect cremation is the inevitable result

ECCLES MUNICIPAL CORPORATION—POPULATION, 34 369

S W

A	[1]
B	Meldrum s front hand fed
C	4 grates
D	2 Lancashire each 28 ft × 7 ft
E	95 feet
F	Steam jet blowers
G	Sewage pumping
H	30 tons
I	[1]

ELLAND URBAN DISTRICT COUNCIL—POPULATION, 10,412

E W

A	1903
B	Meldrum s improved top fed and front fed.
C	3 grates

[1] This installation, which will also comprise machinery for clinker utilization will not be completed until early in 1904

D	1 Lancashire, 30 ft × 8 ft
E	—
F	Steam jet blowers.
G	Electric lighting
[1]H	10 tons
I	This installation has only recently been opened.

EPSOM URBAN DISTRICT COUNCIL—POPULATION, 10,915

S W

A	*
B	Meldrum's front hand fed.
C	4 grates
D	2 Cornish each 16 ft × 6 ft
E	60 feet
F	Steam jet blowers
G	Sewage pumping
H	10 tons.
I	*

FLEETWOOD URBAN DISTRICT COUNCIL—POPULATION, 12 082

E W

A	1900
B	Meldrum's Beaman & Deas top fed.
C	2
D	1 Babcock & Wilcox.
E	—
F	Fan
G	Electric lighting
H	12 tons.
I	—

One additional boiler is installed for coal firing and also a Green's Economiser The power equipment of the electricity works is as follows —Two Willans engines total H P 200, direct coupled to two four pole Johnson and Phillips dynamos, of a total capacity of 600 ampere hours

The detailed figures of the official test are here given

[1] A proportion of sewage sludge is also being destroyed

[2] This installation will not be completed until early in 1904

Test of Meldrum's Beaman and Deas Type of Destructor at the Electric Light Station, Fleetwood

Date of test	September 28, 1900
Duration of test	8 hours
State of weather	Fine
Kind of fuel	Unscreened ashpit refuse (very wet)
Number of cells	2
Area of each grate	25 square feet
Type of boiler	Babcock & Wilcox
Heating surface of boiler	1,420 square feet
Total weight of refuse burned, 14 tons 7 cwt 2 qrs 20 lb	32,220 lb
Weight burned per hour, 1 ton 15 cwt 3 qrs 23 lb	4,027 lb
Weight burned per square foot grate, per hour (50 square feet)	80.5 lb
Total weight of clinker and ash 4 tons 13 cwt 1 qr 0 lb	10,444 lb
Percentage of clinker and ash	32.4 per cent.
Total water evaporated	31,952 lb
Water evaporated per hour	3,994 lb
" " lb of refuse, actual	.916 lb
Water evaporated per lb of refuse from and at 212° F including economiser	1.191 lb
Water evaporated per square foot heating surface	2.8 lb
Temperature of feed water at tank	59° F
Temperature of feed water from economiser	239° F
Average steam pressure	135 lb
Average air pressure	2½ in
Temperature of combustion chamber by copper test	2,000° F
Temperature in main flue before economiser	622° F
Temperature in main flue after economiser	356° F
Average chimney pull	⅜ in

It rained heavily on three consecutive days immediately preceding the test, and the quality of the refuse was exceedingly bad.

FOLKESTONE MUNICIPAL CORPORATION—POPULATION 30 690

The Corporation have lately decided to erect a Destructor of the Horsfall back shovel fed type at a total estimated cost of £14 000

GARSTON (CITY OF LIVERPOOL)—POPULATION, 18 710
E W

A	1901
B	Meldrum front hand fed
C	3 grates
D	1 Babcock & Wilcox
E	—
F	Steam jet blowers
G	Electric traction.
H	25 tons
I	—

The power is fully utilized for electric traction and although no official returns are available it is stated that the power production is highly satisfactory

Two Lancashire boilers for coal firing alone are installed in a separate boiler house The power equipment of the electricity works is as follows —Two Browett Lindley engines total H P 140 direct coupled to two Siemens shunt wound dynamos total capacity 87 K W also a storage battery of 232 W P S cells having a total capacity of 400 ampere hours

GLOUCESTER MUNICIPAL CORPORATION—POPULATION, 47,955
L W

A	1902
B	Heenan back fed
C	4
D	2 Babcock & Wilcox
E	—
F	Fan
G	Electric lighting
H	25 tons.
I	10d.
J	3s

The supplementary coal fired boiler plant comprises four Lancashire boilers each 30 feet long and 8 feet in diameter, with a Green's Economiser. Sufficient steam is provided by the Destructor boilers to charge the batteries which light the city during the night.

The power equipment of the station is as follows:—One 250 H.P. Bellis engine and one 500 H.P. engine of the same make, also one Willans engine of similar capacity. Four 150 K.W. Silvertown dynamos and two 75 K.W. Mather and Platt dynamos. The storage cells number 280 of the E.P.S. type.

GOSPORT URBAN DISTRICT COUNCIL—POPULATION 28,887
S.W.

The Council have just decided to erect a two-cell Destructor of the Horsfall type at the new sewage works in front of two existing boilers of the Lancashire type. The estimated cost of the Destructor installation is given as £1,100.

GORTON URBAN DISTRICT COUNCIL—POPULATION 28,000
S.W.

It has recently been decided to erect a Destructor of the Horsfall type at the Council's sewage outfall works at an estimated cost of £8,816.

GRANTHAM MUNICIPAL CORPORATION—POPULATION 17,598

A	1903
B	Fryer's improved top fed
C	2
D	1 Lancashire
E	80 feet
F	Steam jet blowers
G	Forced draught and disinfector
H	—
I[1]	—

[1] These works are now in course of erection.

Grays Urban District Council—Population, 15,834

E W

A	1901
B	Meldrum front hand fed
C	2 grates

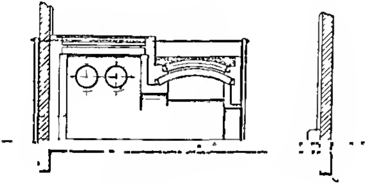

Fig 64 Grays Combined Destructor and Electricity Works
Sectional Elevation

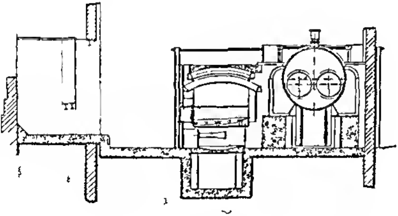

Fig 65 Grays Combined Destructor and Electricity Works
Sectional Elevation

D	1 Lancashire 20 ft × 7 ft
E	100 feet
F	Steam jet blowers
G	Electric lighting
H	8 tons
I	10*d*
J	33

Two supplementary coal fired boilers are installed in a separate boiler house The power equipment of the station comprises the following —Two Reavell engines total *H P*, *300* direct coupled to two British Schuckert four pole dynamos of a total capacity of 200 K W Also 260 D P cells having a total capacity of 350 ampere hours

Some details of the official test of the Destructor are here given

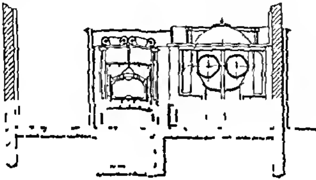

FIG 66 GRAYS COMBINED DESTRUCTOR AND ELECTRICITY WORKS
Sectional Elevation

TEST OF MELDRUMS PATENT "SIMPLEX" REFUSE DESTRUCTOR AT THE COUNCIL'S ELECTRICITY WORKS GRAYS THURROCK ESSEX

F D LONG ESQ A I E E, ENGINEER

Date of test	January 23 1902
Duration of test (starting from cooled furnace)	7 hours
Grate area	50 square feet
Boiler Lancashire 20 ft × 7 ft heating surface	*600 square feet*
Economiser 128 tubes heating surface	1 408 square feet
Refuse delivered (including pots tins etc, not deducted from total)	26 684 lb
Refuse consumed per hour	3 812 lb
Refuse consumed per square foot grate per hour	76¼ lb

Total water evaporated	. . . . .	27,100 lb.
,, ,, ,, per hour	. . .	3,871½ lb.

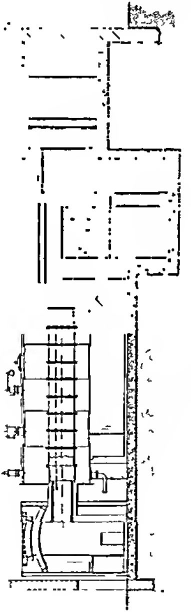

Fig 67. Grays Combined Di[illegible]

Longitudinal Elevation

Water evaporated per lb. of refuse (actual) 1.01 lb.

Water evaporated per lb. of refuse from and at 212° F.	1·22 lb.

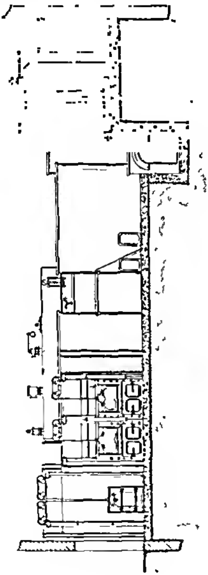

FIG. [illegible]. GRAYS COMBINED DESTRUCTOR AND ELECTRICITY [illegible]
Front Elevation

Temperature of water entering economiser	50° F.
" " leaving economiser, average	299° F.

Average steam pressure, per square inch	.	144 lb.
Total heat units in steam generated	.	4,544,554.
Heat units from economiser	.	967,750

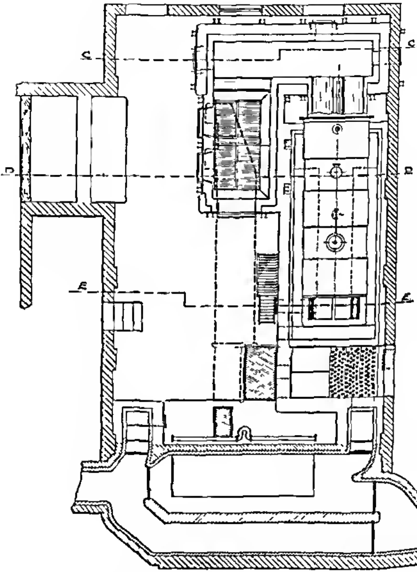

FIG. 63. GRAYS COMBINED DESTRUCTOR AND ELECTRICITY WORKS
Sectional Plan

Percentage of total heat from economiser	.	21 2.
Board of Trade units generated during last 4½ hours	.	272.

Board of Trade units generated per ton of refuse, besides blowing off	35 5
Board of Trade units generated during 3 hours, steam blowing off	215
Board of Trade units generated per ton of refuse during 3 hours	42 4

The general arrangement of this small Destructor installation will be clearly followed by referring to Figs 64 to 69

GRAVESEND MUNICIPAL CORPORATION—POPULATION, 27,196
E W

A	1903
B	Sterling top fed
C	4
D	1 Babcock & Wilcox
E	125 feet
F	Fan
G	Electric lighting
H	25
I	—

Three supplementary coal fired boilers are provided, and the power equipment of the station is as follows —Three Alley and Maclellan engines direct coupled to three Lancashire dynamos, the total capacity being 600 K W , also a 50 K W motor generator set by the Lancashire Dynamo Co balancers and boosters

A storage battery of Verity Cells is provided having a total capacity of 630 ampere hours

GREAT GRIMSBY MUNICIPAL CORPORATION—POPULATION, 63,318
E W

A	1903
B	Horsfall back hand fed
C	4
D	1 Babcock & Wilcox
E	180 feet
F	Steam jet blowers
G	Clinker crusher, mortar mill and electric lighting
H	20 tons
I	—

Great Yarmouth Municipal Corporation—Population, 51,250

A	1902
B	Fryer's improved top fed
C	10
D	1 Multitubular, 60 H P
E	204 feet
F	Natural draught only
G	—
H	78 tons
I	—

The total cost of this installation was £14,000, although the estimated cost was £5,000 less than this figure Very serious difficulties with the foundations explain the serious excess on the estimate

Handsworth Urban District Council—Population, 52 921

A	1901
B	Warner top fed
C	8
D	2 Multitubular
E	200 feet
F	Sturtevant fans
G	Fan engine only
H	50 tons
I	10¾d

Hanley Municipal Corporation—Population, 61,599

A	1902
B	Horsfall top fed
C	8
D	2 Lancashire, each 30 ft × 8 ft
E	120 feet
F	Steam jet blower
G	*Not used at present, but it is intended to supply steam to the electricity works*
H	60 tons

Hartlepool Municipal Corporation—Population, 22 737

A	1901
B	Warner top fed
C	6

D	3 Multitubular
E	150 feet
F	Fan
G	Fan engine only
H	20 tons
I	11*d*

The total cost of the installation (exclusive of the cost of the site) was £5,100, of this sum £2,692 was expended upon the buildings, inclined roadways and chimney

Fig 70 shows an accumulation of refuse on top of the cells, from whence it is charged through the hopper into the cell as required

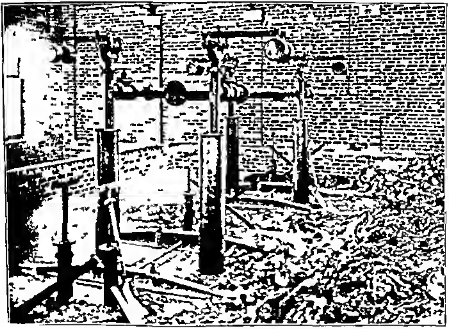

Fig 70 Hartlepool Destructor
View showing Hopper Levers and Refuse on Top of Cells.

Hastings Municipal Corporation—Population, 65,528

A	1889
B	Fryer top fed
C	4
D .	2 Multitubular
E	130 feet

F	Fan
G	Pumping salt water, and also for Disinfector
H	36 tons
I	1s 6½d

Heckmondwike Urban District Council—Population, 11,000

Two Installations

	1	2
A	1883	1900
B	Fryer top fed	Horsfall back hand fed
C	3	2
D	1 Multitubular	1 Babcock & Wilcox
E	—	105 feet
F	Steam jet blower	Steam jet blower
G	—	Works purposes only
H		11 tons
I	—	1s

Hereford Municipal Corporation—Population, 21,328

S W

A	1897
B	Meldrum front hand fed
C	4 grates
D	2 Galloway each 22 ft × 6 ft 6 in
E	45 feet
F	Steam jet blowers
G	Sewage pumping etc
H	10 tons
I	9d

This installation has been remarkably successful and it possesses several interesting features It is one of the few works where Destructor cells have been adapted to existing boilers previously fired with coal The same chimney is also used, and being only 45 feet in height and 2 3" internal diameter, is probably the smallest Destructor chimney in this country

The works are situated in close proximity to excellent residential property The cost of the Destructor has been long since recouped by the saving of the coal bill

The total weight of refuse produced in Hereford is about 25 tons, and it is interesting to note that 10 tons only, collected as

[1] Added in 1893

close as possible to the works, suffices to provide the whole of the power required at the sewage works

Complete details of the official tests are here given —

Date of test	May 4 1898	May 5 1898	May 6 1898
Duration of test	10 hours (7 a m to 5 p m)	10¼ hours (7 15 a m to 5 30 p m)	10 hours (7 a m to 5 p m)
Kind of fuel burned	Unscreened ashpit refuse	Unscreened ashpit refuse	Unscreened ashpit refuse
Total weight of fuel burned	19 768 lb	19 012 lb	19 712 lb
Weight burned per hour	1 9[illegible]6	1 855	1 971
Weight burned per sq ft of grate area per hour	54 88	51 52	54 75
Total weight of clinker and ash	6 6[illegible]	6 804	5 040
Percentage of clinker and ash	33 88 %	35 7 %	[illegible]56%
Percentage of moisture	24 5%	27 0%	2[illegible] 0%
Total water evaporated	2[illegible] [illegible]54 lb	[illegible]5 [illegible]0 lb	20 800 lb
Water evaporated per hour	2 625	2 494	2 080
Water evaporated per lb of refuse actual	1 3[illegible]	1 34	1 51
Water evaporated per lb of refuse from and at 212° F	1 59	1 60	1 82
Temperature of feed water	48	48	48
Average steam pressure	70 lb	[illegible]0 2 lb	70 32 lb
Average steam pressure at blowers	64 37	64 55	65 21
Average air pressure under grates by water gauge	1 45 in	1 37 in	1 82 in
Chimney pull by water gauge	[illegible]	[illegible]	[illegible]
Temperature in combustion chamber by copper test	Over 2 000° F	Over 2 000° F	Over 2 000° F
Temperature of waste gases leaving damper	25 Readings 611 5° F	36 Readings 638 8° F	41 Readings [illegible]15 12° F
Percentage of carbonic acid (CO_2) by Econometer	2[illegible] 15 58 %	3[illegible] 16 84%	41 16 27%
Percentage of carbonic acid Orsat app	2[illegible] 14 5[illegible]	18 16 83	14 16 38 %
Percentage of free oxygen (O) Orsat app	[illegible]0 [illegible] 40 %	18 3 54 %	14 3 74%
Percentage of carbonic oxide (CO) Orsat app	[illegible]0 nil	18 nil	14 nil
Size of boiler 22 ft x 8 ft with two flues each 2 ft			
Area of grate 36 square ft			

One-and-a-half Million Gallons of Sewage is pumped per day of ten hours on an average to a height of 36 feet

The clinker is utilized on the bacteria beds, this is one of the very few works of the kind where the gases of combustion are being constantly analysed

HEYWOOD MUNICIPAL CORPORATION—POPULATION, 25 461
S W

A	1902
B	Meldrum front hand fed
C	2 grates
D	1 Lancashire 20 ft × 7 ft
E	90 feet
F	Steam jet blowers
G	Sewage pumping
H	25 tons
I	—

HOLYHEAD MUNICIPAL CORPORATION—POPULATION, 10 079
E W

A	—
B	Meldrum front hand fed
C	2
D	1 Babcock & Wilcox
E	120 feet
F	Steam jet blowers
G	Electric lighting
H	10 tons
I	—

This installation is not likely to be completed until early in 1904

HORBURY URBAN DISTRICT COUNCIL—POPULATION, 6 736
S W

A	1903
B	Horsfall back hand fed
C	2
D	2 Cornish
E	[illegible]0 feet
F	Steam jet blowers
G	Sewage pumping
H	[illegible] tons
I	Works now in course of erection

HORNSEY MUNICIPAL CORPORATION—POPULATION, 77 938

A	1889 1893 and 189[illegible]
B	Warner top fed
C	12
D	1 Multitubular
E	217 feet
F	Fan
G	Clinker crusher mortar mill and fan engine only
H	75 tons
I	97[1]

The cost of this installation is given as £9 628 but this is exclusive of the cost of the forced draught apparatus which was added about two years since mainly owing to difficulties experienced in dealing with trade refuse

During the year 1902 a total of 20 648 tons of refuse was passed through the Destructor this weight being made up as follows —

House refuse	20 374 tons
Vegetable market	230
Fish offal	44

It is interesting to note that the quantity of refuse disposed of at these works seven years ago was only 10 092 tons per annum

In addition to a clinker crusher and mortar mill a Musker flag plant has also been installed and a considerable portion of the clinker is utilized

HUDDERSFIELD MUNICIPAL CORPORATION—POPULATION 95 047

TWO INSTALLATIONS

	1	2 S W
A	1891 92	1898
B	Fryer top fed	Horsfall back to back fed
C	10	2
D	1 Multitubular 11 ft × 7 ft	2 Cornish each 22 ft × 5 ft
E	180 feet	
I	—	[illegible]

[1] This has possibly been increased since forced draught was added to the cells.

G	Works purposes	Sewage pumping and sludge pressing
H	50 tons	20 tons
I	10½*d*	—

HULL MUNICIPAL CORPORATION—POPULATION, 240,739

TWO INSTALLATIONS

	1	2
A	1882	1902
B	Fryer top fed	Horsfall top fed
C	6	12
D	1 Multitubular	2 Babcock & Wilcox
E	180 feet	110 ft × 7 ft 6 in internal diameter
F	Steam jet blowers [1]	Steam jet blowers
G	Works purposes only	Forced draught, hoist and works lighting
H	45 tons	90 tons
I	1s 3d	—

HUNSTANTON URBAN DISTRICT COUNCIL—POPULATION, 1,893 W W

A	1899
B	Meldrum front hand fed
C	2 grates
D	1 Cornish
E	50 feet
F	Steam jet blowers
G	Water pumping
H	3½ tons
I	1s

The installation is of much interest, not only because it is the smallest Destructor yet installed in this country, but owing to the fact that from the combustion of some 3½ tons of refuse daily sufficient steam is produced to operate a modern water pumping plant

The Destructor installation is very complete, comprising a two grate unit Destructor erected in front of a high pressure Cornish boiler, with which a Schwoerer Superheater is provided and also

[1] Added in 1896

a Meldrum regenerator for heating the air supply for combustion The whole plant with its combination for power production affords a remarkable object lesson to small seaside and health resorts

HYDE MUNICIPAL CORPORATION—POPULATION, 32,766

S W

TWO INSTALLATIONS

	1	2
A	1893	1903
B	Warner top fed	Meldrum front hand fed
C	4	6 grates
D	1 Multitubular	1 Lancashire 30 ft × 8 ft 6 in.
E	180 feet	Same chimney
F	Meldrum's steam jet blowers to 1 cell[1]	Steam jet blowers
G	Mortar Mills etc	Sewage pumping
H	24 tons	30 tons
I	1*s* 2*d*	—

Installation No 2 will displace No 1, and the power will be fully utilized for sewage pumping

IPSWICH MUNICIPAL CORPORATION—POPULATION 66,630

E W

A	1903
B	Meldrum front hand fed
C	4 grates
D	1 Lancashire 30 ft × 8 ft
E	175 feet
F	Steam jet blowers
G	Electric lighting and traction.
H	40 tons
I[2]	—

The Destructor installation is part of a very comprehensive scheme just now approaching completion Professor Kennedy being the consulting engineer

The whole of the available steam from the Destructor boiler

[1] Added in 1900

[2] Works not yet in operation.

will be utilised for generating electric power, and to obtain the maximum advantage therefrom it is likely that the refuse will be destroyed within sixteen hours daily instead of throughout the whole twenty-four hours.

The Destructor will be complete in every respect; the Lancashire boiler will work at a pressure of 200 lb. to the square inch, and a Musgrave Dixon Superheater will be fixed in the [illegible] and a Green's Economiser and Regenerator [illegible] also provided.

Kettering Urban District Council—Population [illegible]
E. W.

A	[illegible]
B	[illegible]
C	[illegible]
D	1 Lancashire [illegible]
E	[illegible]
F	[illegible]
G	[illegible]
H	[illegible]
I	—

This is part of a [illegible] which has been carried out under the [illegible] of Professor Kennedy at an estimated total cost of £423[illegible].

Kings Norton and Northfield Urban District Council—Population 57,120

A Destructor of the Horsfall type is being installed for the Council.

Kingston-on-Thames Municipal Corporation—Population [illegible]

A	[illegible]
B	3 [illegible] Horsfall Destructor [illegible]
C	—

* Works not yet in operation.

D	1 Babcock & Wilcox
E	150 feet
F	Fan
G	Works purposes only
H	30 tons
I[1]	—

The cost of the Destructor and boiler was £3 050 this being exclusive of the cost of the foundations buildings and chimney, the total estimated cost being £8 370

The direct charging arrangement for tipping direct from the carts is Marten's patent made by Messrs Meldrum Bros, Ltd The same system of charging has been in use at the Tooting Destructor (Metropolitan Borough of Wandsworth) for three years past with very satisfactory results

LANCASTER MUNICIPAL CORPORATION—POPULATION 40 329

E W

A	1901
B	Meldrum front hand fed
C	8 grates
D	2 Lancashire each 30 ft × 8 ft
F	—
F	Steam jet blowers
G	Electric traction
H	30 tons
I	1s 4d

In addition to the Destructor boilers three supplementary coal fired boilers are provided these being also of the Lancashire type 30 feet long and 8 feet in diameter Green's Economisers are also installed as also with the Destructor boilers

The power plant comprises —Four Willans engines direct coupled to four dynamos the total capacity being 420 K W One 200 K W Westinghouse set and 120 Epstein cells

Details of the official test of this Destructor are here given

[1] Works not yet in operation

Lancaster Corporation Destructor

Result of Test.

Date of test	February 7, 1902
Duration of test	12 hours 26 min.
Number of cells	4
Grate area	100 square feet
Type and size of boiler	Lancashire 30 ft. × 8 ft.

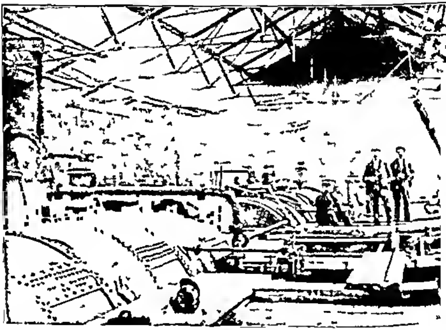

Fig. 71.—Lancaster Combined Destructor and Electricity Works.
View of Boilers.

Refuse consumed (total)	33 tons 0 cwt. 1 qr.
Refuse consumed in pounds	74,920 lb.
Water evaporated, total (actual)	9,938 gallons
per hour (actual)	799 gallons
per lb. of refuse (actual)	1.33 lb.
per hour from and at 212° F.	982 gallons
Water evaporated per lb. of refuse from and at 212° F.	1.63 lb.

Average steam pressure	164 lb
„ temperature of feed water	40 5° F
Weight of clinker	25 498 lb
Percentage of clinker	34 per cent
Average percentage of carbon dioxide in flue gases	15 5 per cent
Temperature of combustion chamber	Over 2 000° F as copper could always be melted
Maximum temperature of combustion chamber	Unknown melted nickel 2 650° F
Average temperature of gases leaving boiler	995° F
„ temperature of gases leaving economiser	590° F
Average temperature of heated air from Regenerator	478° F

Fig 71 is a view on top of the cells at Lancaster during course of erection This view should be of interest to the student, clearly showing as it does the prominence of steam boilers in connection with the modern Destructor

LEAMINGTON MUNICIPAL CORPORATION—POPULATION 26 888

S W

A	1903
B	Horsfall back hand fed
C	6
D	2 Lancashire each 30 ft × 7 ft 6 in
E	90 ft × 5 ft internal diameter
F	Steam jet blowers
G	Sewage pumping
H	25 tons
I	—

The sewage is pumped to the sewage farm a mile and a half distant, the lift being from 80 to 120 feet The chimney was previously used for coal fired boilers

LEEDS MUNICIPAL CORPORATION—POPULATION, 428,968
FOUR INSTALLATIONS

	No 1 Burmantofts	No 2 Armley Road	No 3 Kidacre St	No 4 Meanwood Rd
A	*1876, 1883 & 1887*	*1877, 1884 & 1886*	*1891 & 1894*	*1895*
B	Fryer top fed	Fryer top fed	Horsfall top fed	Horsfall top fed
C	14	12	16	8
D	1 Babcock & Wilcox	1 Multitubular	2 Multitubular	2 Babcock & Wilcox
E	120 feet	120 feet	144 feet	240 feet
F	*Steam jet* blowers *	*Steam jet* blowers †	*Steam jet* blowers	Steam jet blowers
G	Forced	draught purposes	and only	Works
H	—	—	—	—
I	10½*d*	10½*d*	10½*d*	10½*d*

* Added in 1887 † Added in 1894

FIG. 72 LEEDS (MEANWOOD ROAD) DESTRUCTOR
View of Building

As will be observed, Leeds is very well provided for, having a total number of fifty cells, nearly half of which are of modern design, while the remainder are equipped with forced draught The total cost of the various installations is given as £48,525, including the cost of the sites

Fig 72 is an external view of the more recently erected plant (No 4) at Meanwood Road

LEICESTER MUNICIPAL CORPORATION—POPULATION, 211,581

FOUR INSTALLATIONS

	No 1 Newham Street	No 2 Mill Lane	No 3 Lero	No 4 West Humberstone
A	1890	1893	1894	1902
B	Fryer top fed	Borough Surveyor's design, top fed	Borough Surveyor's design, top fed	Fryer's improved Boulnois Wood & Brodie's, top fed
C	6	6	6	6
D	3 Multitubular	1 Multitubular	1 Multitubular	3 Babcock & Wilcox
E	160 feet	180 feet	180 feet	180 feet
F	Fan	Fan	Fan	Fan
G	Supplied to an adjoining engineering works	Clinker crusher, mortar mill and works lighting	Works purposes	Works purposes
H	45 tons	45 tons	45 tons	—
I	8½*d*	8½*d*	8½*d*	—

The estimated cost per cell of the first three installations is given as follows

No 1 Newham Street	£1 116 per cell	Including buildings, chimney and machinery
No 2 Mill Lane	£1,345 " "	
No 3 Lero	£1,475 " "	

Some particulars of the refuse disposed of at the above three works during the year 1902 will doubtless be of interest

De tructors	House Refuse		Trade Refuse		Meat Tons	Mat tresses
	Loa ls	T ns	Loa ls	Tons		
No 1 Needham Street	12,266	13 489	320	101	80	472
No 2 Mill Lane	13 878	13 472	904	273	74	290
No 3 Lero	12 034	13 181	1 361	587	280	246

No 4 Installation known as West Humberstone destructor, will undoubtedly prove to be a distant advance on those previously erected The estimated total cost of this plant is given as £6 755 19s 0d

In thus so completely equipping this important town with destructors an excellent example has been set for the benefit of many large provincial towns Mr E G Mawbey, M I C E Leicester's eminent Borough Engineer and Surveyor, has done wisely in erecting four separate installations in different parts of so large a town thus greatly expediting the collection and also keeping the collection cost within reasonable limits

At the various works a number of mortar mills are installe and a considerable quantity of mortar is made which yields fair profit At the West Humberstone Works a flag plant ha been provided

LEIGH MUNICIPAL CORPORATION—POPULATION, 40,001

The Council have recently decided to instal a destructor o the " Horsfall " type

LEVENSHULME URBAN DISTRICT COUNCIL—POPULATION, 11,435

A two cell destructor of the " Heenan " type is now in hand for this Council, the estimated cost of the same being £4,500

LEYTON URBAN DISTRICT COUNCIL—POPULATION, 98,999 S W

A	1898
B	Meldrum's " Beaman & Deas " type, top fed
C	8

D	2 Babcock & Wilcox [1]
E	150 feet
F	Fan
G	Sewage pumping
H	60 tons [2]
I	1s 7d

LIVERPOOL MUNICIPAL CORPORATION—POPULATION, 710,737
FOUR INSTALLATIONS

	No 1	No 2	No 3	No 4 F W
	Chaucer's St	Rathbone Rd	Toxteth Park	Cobb's Quarry
A	1891 & 1893	1893	1895	1900
B	Fryer's top fed	Fryer's top fed	Fryer's improved top fed	Fryer's improved top fed
C	24	6	8	8
D	1 Multitubular 11 ft × 8 ft 1 Stirling water tube	—	1 Multitubular, 12 ft × 7 ft	4 Babcock & Wilcox
E	170 feet	—	180 feet	200 feet
F	—	—	—	Fans
G	Mortar mills, clinker crusher, works lighting etc	—	Works only	Electric traction
H	Total	about	300	tons
I	—	—	—	8½d

Under the control of Mr J A Brodie, M I C E, the destructor installations in Liverpool have been developed and possess a very satisfactory record, more especially perhaps installation No 4, known as Cobb's Quarry

Some 30 electric cars are operated daily by power produced from the refuse, and the sale of electrical energy to the Electricity

[1] The Council have recently decided to instal an additional boiler in connection with the Destructor at an estimated cost of £1,335

[2] Refuse and pressed sludge

Department yields a handsome return to the Cleansing Department, the price paid being ·35*d* per unit

Some details of an evaporative test made with the destructor at Cobb's quarry are here given

St Domingo Destructor, Liverpool

	Tons	cwt	qr	lb
Total refuse burnt in 8 cells in 24 hours	123	16	0	0
Note —Twenty three tons were burnt in 6 hours, between 12 midnight and 6 a m The boilers were not in work during this period The heat passed through the flues direct to the chimney	23	0	0	0
Refuse burnt in 8 cells in 18 hours	100	16	0	0
" " 8 cells per hour	5	11	0	0
" " per cell per hour	0	13	3	14
" " per square foot of grate area per hour	62 16 lb			
Total quantity of water evaporated in 18 hours	262,460 lb			
" " " " per hour	14 581 lb			
" " " per lb of refuse burnt	1 173 lb			

Output of Electricity in 18 Hours

(The output is restricted at present to the requirements of the Tramways Department)

No 1 Engine	1,650 units,	for tramways
No 2 "	1,779 "	"
No 3 "	234 "	for public lighting
	3,663 "	

A further destructor of the improved "Fryer" type is now in course of erection at "Laverock Bank," the power from which will be fully utilized for electrical purposes

This installation together with additional cells not included in the tabular statement, will comprise in all some 65 cells, so that Liverpool may claim to be well equipped for final and sanitary disposal of its refuse

The clinker is fully utilized for a variety of purposes; a considerable quantity of mortar is made, as also some 600 paving flags daily, while some thousands of tons of clinker were used for concrete for the bridges and roads over St George's Dock, etc.

In the future it is likely that considerable quantities of clinker will be used in the construction of artizans' dwellings. The experiments in this direction now being conducted by Mr Brodie are referred to elsewhere. With the absorption of Garston, possessing its own destructor, Liverpool is on the whole splendidly equipped, and it must be admitted that the progress which has been made all tends to clearly show the weakness and inefficiency of the whole system of sending the refuse out to sea.

LIVERSEDGE URBAN DISTRICT COUNCIL—POPULATION, 14,980

A	1900
B	Horsfall's back hand f. f.
C	2
D	1 Babcock & Wilcox
E	30 ft × 3 ft 6 in int'rnal diameter
F	Steam jet blowers
G	Forced draught and works purposes only
H	13 tons
I	—

LLANDUDNO URBAN DISTRICT COUNCIL—POPULATION, 9,810 E W

A	1898
B	McIlraith's Beaman & Deas t. f. f.
C	4
D	2 Babcock & Wilcox
E	120 ft
F	Fan
G	Electric lighting
H	15 tons
I	1s 3½d
J	32

In addition to the destructor boilers, 4 Babcock and Wilcox boilers are also provided for supplementary coal firing, also a Green's Economiser.

The power equipment of the station is as follows:—3 Bel...

Silvertown two pole under type dynamos, 1 Allen Silvertown four pole dynamo 2 Allen Crompton Multipolar machines, 150 k w each total H P 1,100, also 250 Pritchett & Gold's cells of 250 ampere hours capacity

The total cost of the destructor was £6,032, of which sum £1,085 has already been repaid A few figures extracted from the statement for the third year of operations are of interest

Load factor	8 24 per cent
Fuel cost	69d per unit
Works	1 35d „ „
Total	1 97d „ „
Net profit	£679

It is also worthy of note that this combined works has paid from the first year of operation

LONGTON MUNICIPAL CORPORATION—POPULATION, 35,815
TWO INSTALLATIONS

	No 1	No 2
A	1887	1895
B	Fryer's top fed	Warner's top fed
C	4	2
D	1 Multitubular	1 Multitubular
E	150 feet	Same chimney used
F	—	Fan
G	Works purposes only	Works purposes only
H	3½ tons	
I	11d	11d

LOUGHBOROUGH MUNICIPAL CORPORATION—POPULATION, 21,508
TWO INSTALLATIONS

	1	2 S W
A	1896	1903[1]
B	Coltman's	Fryer's top fed
C	1	2

[1] Now in course of erection

D	1 Lancashire	1 Babcock & Wilcox
E	Separate flue	Same chimney
F	Fan	Fan
G	Sewage pumping	Sewage pumping
H	20 tons	—
I	1s 3d	—

LOWESTOFT MUNICIPAL CORPORATION—POPULATION 29,850

A	1899
B	Horsfall's back hand fed
C	4
D	1 Babcock & Wilcox
E	120 ft × 6 ft 6 in internal diameter
F	Steam jet blowers
G	8 H P engine for mortar mill and forced draught
H	28 tons
I	11½d

The clinker sells freely at 8d per load at the Works, a portion is converted into mortar and sells freely at 5s per load

LYTHAM URBAN DISTRICT COUNCIL—POPULATION, 7,185

A	1902
B	Meldrum's front hand fed
C	2 grates
D	1 Cornish 20 ft × 6 ft 6 in
E	50 ft × 3 ft 9 in internal diameter
F	Steam jet blowers
G	Sewage pumping and works lighting
H	10 tons
I	8d

An external view of the Lytham Works is shown in Fig 73 The writer is indebted to Mr A J Price, the Surveyor, for this photograph The whole of the steam power required at these works is obtained from refuse alone, the dry weather flow of sewage being 800 000 gallons daily, this volume being lifted by Gwynne's centrifugal pumps Power is also supplied for driving a 7 brake horse power Robey vertical high speed engine and dynamo for works lighting purposes, 6 arc lamps and 24 16 C P incandescent lamps being prov[illegible] le combined se[illegible]

was carried out well within the estimate of £10 560 and reflect great credit upon Mr A J Price Surveyor to the Urban District Council

Evesham Co... s top fed

MANCHESTER ...

A ...

B ... Destructor and Sewage Wo...

C ... View of Building

D ...

MUNICIPAL CORPORATION—POPULATION, 5...

First in 1876 with several extensions

Fryers old type and Whiley

114 and 28

152

200 feet

See below

Mortar mills works purposes sere...

—

—

Warners top

2

1 Multitubular

Same chimney n ed

Fan

Works purposes only

ton

11d

...N—POPULATION

...

2 ...

1903 ...

...ers top

...ly been decided to erect a 2 cell Meldrum Des...

...the

...forced draught and grates fitted to the 12 cr...

...are mostly of the Gallway type and are ...

...structors Sorted refuse is burned

It is interesting to note that the first destructor cells ever erected in this country were installed at the Water Street Depot of Manchester Corporation. The first two cells are illustrated in Fig. 1.

For some years past an extensive system of sorting and utilization has been employed in Manchester, the destructors and boilers therefore only deal with a proportion of the civic waste.

L. W.

MANSFIELD MUNICIPAL CORPORATION—POPULATION, 21,445

A	1903
B	Heenan's back fed
C	[illegible]
D	2 Babcock & Wilcox
E	150 feet
F	Fan
G	Electric lighting
H	20 tons
I	—

Three Lancashire boilers for supplementary coal firing are provided in addition to the destructor boilers. The power equipment of the station comprises high speed triple expansion condensing engines direct coupled to compound multipolar generators. The station is laid out for a total capacity of 1 000 k.w., including a large storage battery.

E. W.

MEXBOROUGH URBAN DISTRICT COUNCIL—POPULATION 10,42[illegible]

A	1902
B	Meldrum's front hand fed.
C	3 grates
D	1 Lancashire 24 ft. × 7 ft. 6 in.
E	120 feet
F	Steam jet blowers
G	Electric lighting
H	20 tons
I	11 *l*

One supplementary coal fired boiler of the Lancashire type, [illegible]

[illegible]

D	2 Babcock & Wilcox
E	90 ft × 5 ft internal
F	Steam jet blowers
G	Works purposes clinker crushers mortar mills
H	26 tons
I	8 l

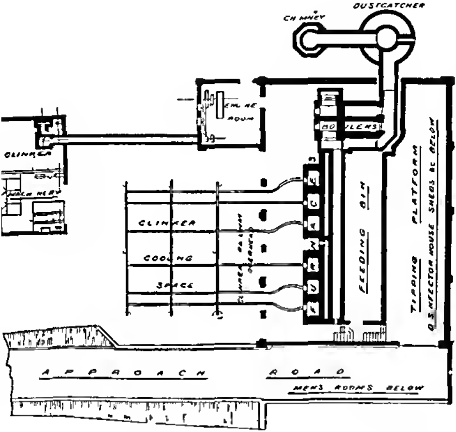

FIG 74 Moss Side Destructor Plan

This is one of the best examples of this particular type of Destructor in this country and it is to be regretted that the power cannot be fully utilized

The general arrangement of the plant will be seen by referring 74 Only four cells are used at one time The total cost of was £10 300 The mortar made sells freely at

similar size to the destructor boiler is provided, the working pressure of both boilers being 150 pounds steam being supplied to the engines at 140 pounds pressure

The power equipment of the station is as follows: Two coupled sets capable of developing 50 k w at 440 to 480 volts at a speed of 550 revolutions per minute there is also a Balancer Booster consisting of four machines coupled together

Adjoining the engine room is the accumulator room containing 240 cells having an output of 300 ampere hours at a 10 hour rate or [illegible] ampere hours at a [illegible] hour rate

The public lighting consists of 213 street lamps each containing 2 16 C P lamps and fitted with prism globes also 15 enclosed arc lamps of 1000 C P each The public lighting replaces 139 gas lamps of lower candle power which formerly cost the Council [illegible] per annum

The total cost of the combined installation including the site, was about £18,500 The total works cost per unit generated is given as 1·98*d* The Electricity Committee pay the Sanitary Committee ·7*d* per unit generated the latter paying the cost of stokers and coal also the interest and depreciation on the destructor

F W

Morecambe Municipal Corporation—Population, 11,798

A	1902
B	Sterling top fed.
C	4
D	1 Lancashire
E	120 feet
F	Fan
G	Electric lighting and mortar mills
H	11 tons
I	1s 0½*d* [1]

Moss Side Urban District Council—Population, 26 677

A	1902
B	Horsfall's top fed
C	6

[1] This figure applies to the official test of 12 hours

D	.	2 Babcock & Wilcox
E		90 ft × 5 ft internal
F		Steam jet blowers
G		Works purposes, clinker crushers, mortar mills
H		26 tons
I	.	8*d*

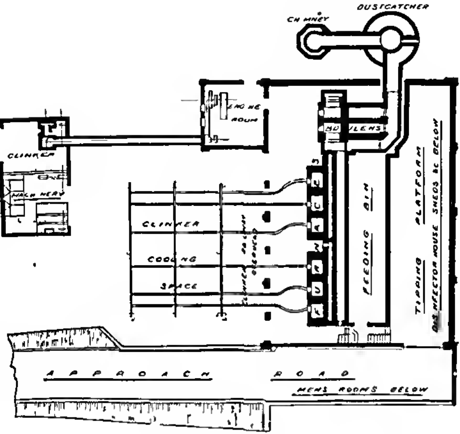

Fig 74 Moss Side Destructor Plan

This is one of the best examples of this particular type of Destructor in this country, and it is to be regretted that the power cannot be fully utilized

The general arrangement of the plant will be seen by referring to Fig 74 Only four cells are used at one time The total cost of the installation was £10,300 The mortar made sells freely at

4s 6d per ton and the clinker rough and screened at 6d and 3s per ton respectively

A complete clinker crushing and screening plant is installed which absorbs about 25 H P during the day for driving while at night a 20 k w dynamo is in use for works lighting purposes but these together with the forced draught blowers offer the only outlet at present for power utilization

L W

NELSON MUNICIPAL CORPORATION—POPULATION, 32 816

A	1900
B	Meldrum s front hand fed
C	4 grate
D	1 Lancashire 30 ft × 8 ft
E	180 feet
F	Steam jet blowers
G	Electric traction
H	30 tons
I	1s
J	40

Here the destructor was erected well in advance of the electricity works but a number of tests under varying condition and over extended periods carried out by the Health Superintendent Mr J A Priestley quite satisfied the authorities that the combination would be advantageous

The writer is indebted to Mr J A Priestley for the interesting charts and diagrams reproduced in Figs 75 76 and 77

One interesting feature introduced in connection with the destructor was the offal charging hopper and hearth so arranged that this most objectionable refuse is readily charged without handling and is placed in such a position in the cell that the fumes as driven off must pass over 100 square feet of active fire before reaching the combustion chamber and boiler This effective method of dealing with offal will be readily followed by referring to Fig 78

Two 30 × 8 Lancashire boilers for supplementary coal firing are provided in addition to the destructor boiler The power equipment of the station is as follows —3 Willans engines of 300

—NELSON DESTRUCTOR—

8 HOURS TEST

DIAGRAM OF TEMPERATURE IN COMBUSTION CHAMBER

TAKEN WITH A CALLENDAR'S ELECTRICAL RECORDING PYROMETER.

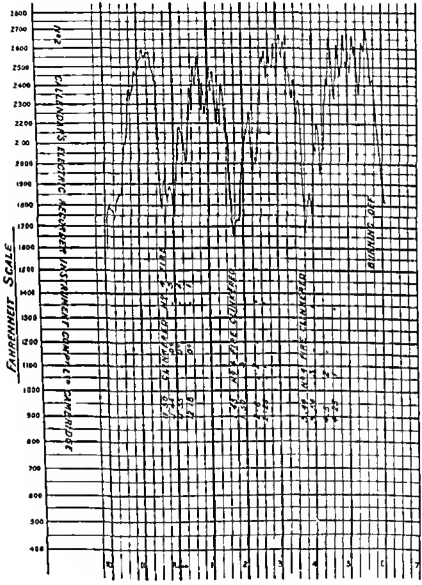

FIG. 75

H P each, and 3 Bruce Peebles dynamos each 200 k w, also 240 Tudor cells

Details of three evaporative tests are here given, and as these were made under entirely different conditions they are worth careful study and comparison

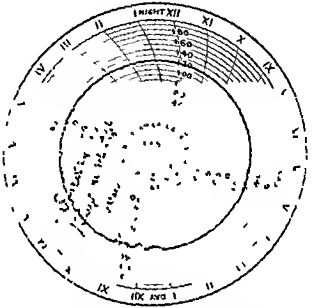

FIG. 76. NELSON COMBINED DESTRUCTOR AND ELECTRICITY WORKS
Steam Pressure Recorder Diagram

TEST A

RESULT OF TEST MADE AT NELSON DESTRUCTOR, 20TH DECEMBER, 1900

Duration of test	9½ hours		
Number of cells	4		
Total grate area	100 sq ft		
Boiler Lancashire 30 ft × 8 ft heating surface	980 sq ft		
Refuse consumed—	Tons	cwt	qr
Unscreened ashpit refuse	22	18	3
Greens and light refuse	1	4	0
Slaughter house offal	0	1	0
	24	3	3

efuse other than ashes	5 per cent
efuse consumed, total	51,180 lb
,, ,, per hour	5 703 lb
,, ,, per square foot grate area per hour	57 lb
'ater evaporated	,, 68580 lb
,, ,, per hour actual	7 220 lb
,, ,, from and at 212 F average	8 650 lb
,, maximum	9,480 lb
,, ,, per lb of refuse actual	1 266 lb
,, from and at 212 F	1 516 lb
,, per sq ft heating surface per hour from and at 212 F	8 77 lb

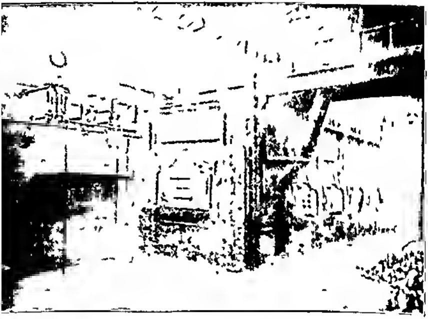

FIG 78 NELSON COMBINED DESTRUCTOR AND ELECTRICITY WORKS
View of Cell and Offal-Charging Hopper

Average steam pressure	118 lb
Weight of clinker remaining	11,473 lb
Percentage of clinker to refuse consumed	21 18 per cent
,, organic matter in clinker	Nil
,, CO_2, average	12 21 per cent.
,, ,, highest reading	18 20 ,,
,, ,, lowest reading clinkering	6 40 ,,

Average temperature of feed water		63 4° F.
" "	combustion chamber, 17 readings	2,200° F
Highest "	" " melting nickel	2,650° F
Lowest "	" " thermophone	1 570° F.
Average "	in side flues 24 readings	982° F
" "	in main flue, 21 readings	596° F
" "	air entering regenerator	64° F
" "	air leaving regenerator, 19 readings	346° F.
" ashpit pressure		1 85 inches
" vacuum in main flue		1 53 in
" "	in blower boxes	35 in
" "	under regenerator, 10 a m to 1 40 p m	1 375 in
" "	" " 1 40 to 7 30 p m	545 in
" "	in downtake, 10 a m to 1 40 p m	875 in
" "	1 40 to 7 30 p m	375 in
" time taken to clinker one fire		5 min 36 secs
" " between each clinkering		1 hr 54 min
Number of times each fire clinkered		Five
Damper full open to 1 40 p m area		10 2 sq ft
" partly closed after 1 40 p m, area		5 sq ft

ANALYSIS OF CLINKER RESIDUE

Silica	40 0	per cent
Lime	11 2	"
Alumina	18 5	"
Ferric oxide	22 8	"
Magnesia manganese and alkalies	6 0	"
	100 0	"

NOTE —Boiler was not clothed when this test was made

TEST B

RESULT OF TEST AT NELSON, 19TH FEBRUARY TO 16TH MARCH, 1901

Duration of test	473½ hours		
Number of cells	Four		
Total grate area	100 sq ft		
Lancashire boiler, 30 ft × 8 ft heating surface	980 sq ft		
Refuse consumed	Tons	cwt	qr
Unscreened ashpit refuse	571	12	1
Light refuse	29	11	3
Vegetable refuse	9	0	3
Fish and slaughter house offal	16	18	0
	627	2	3
Pots, tins, etc, not burned	13	3	1
Net amount consumed	613	19	2

Refuse, other than ashes	9 per cent
„ consumed total	1 371 104 lb
„ „ per hour	2 902 lb
„ „ per sq ft grate area per hour	2[illegible] lb
Water evaporated	2 125 980 lb
„ per hour actual	4 490 lb
„ „ from and at 212° F	5 379 lb
„ lb of refuse actual	1 516 lb
„ „ from and at 212° F	1 870 lb
Average steam pressure	120 lb
Weight of clinker remaining	415 236 lb
„ fine ashes from under grates	[illegible] lb
„ other residuals	68 912 lb
Percentage of clinker to refuse consumed	30 20 per cent
„ ashes	1 38
„ other residuals	5 10
„ CO_2 average	11 16
„ highest reading	17 [illegible]
„ lowest	9 10
Average temperature of Feed water	59 8° F
„ combustion chamber 51 readings	1 [illegible] F
Highest	2 10[illegible] F
Lowest	92[illegible] F
Average in side flues 45 readings	651 F
Highest	82[illegible] F
Lowest	[illegible]2[illegible] F
Average main flue 43 readings	410 F
Highest	[illegible]30 F
Lowest	320 F
Average downtake 54 readings	1 070 F
Highest	1 1[illegible]0 F
Lowest	700 F
Average of heated air 34 readings	243° F
ashpit pressure 43 readings	1 50 in
vacuum in main flue 33 readings	1 30 in
in [illegible] boxes 36 readings	20 in
[illegible] regenerator 38 readings	03 in
over	80 in
in air conduit 34 readings	11 in

Maximum daily evaporation during test from and at 212° F	1 9[illegible] lb
Minimum	1 64 lb
Rainfall throughout test	2 2 in
Proportion of steam produced used by forced blast	15 per cent

Test C

Result of Test made at Nelson Destructor 25th April 1901

Duration of test	8 hours		
Number of cells	4		
Total grate area	100 sq. ft.		
Lancashire boiler 30 ft. × 8 ft. heating surface	986 sq. ft.		
Refuse consumed—	Tons	cwt.	qr.
Unscreened ashpit refuse	24	2	0
Green and light refuse	0	18	1
Fish offal	0	2	0
	25	2	1
Pots, tins, etc., not burned	0	12	3
Net amount consumed	24	9	2

Refuse other than ashes	4 per cent.
consumed, total	54,824 lb.
per hour	6,853 lb.
per sq. ft. grate area per hour	68.5 lb.
Water evaporated	91,600 lb.
per hour, actual	11,450 lb.
from and at 212° F., average	13,44[illegible] lb.
maximum	16,102 lb.
per lb. of refuse, actual	1.67 lb.
from and at 212° F., average	1.96 lb.
from and at 212° F., maximum	2.35 lb.
per square ft. heating surface per hour from and at 212° F.	13.6 lb.
Average steam pressure	122 lb.
Weight of clinker remaining	15,932 lb.
fine ashes from under grate	1,008 lb.
Percentage of clinker to refuse consumed	29.06 per cent.
ashes "	1.83 "
CO_2 average, 30 readings	14.40
highest reading	19.80 "
lowest reading, clinkering	4.80
Average temperature of feed water	83° F.
combustion chamber, recorder	2,2[illegible]7° F.
Highest "	2,693° F.
Lowest "	1,666° F.
Average in downtake, 20 readings	1,306° F.

Average	in side flues, 28 readings	922° F
Highest	,, ,, ,,	1,150° F
Lowest	,, ,, ,, at commencement	562° F
Average	,, in main flue, 29 readings	666° F
Highest	,, ,,	770° F
Lowest	,, at commencement	500° F
Average	air entering regenerator	82° F
,,	air leaving 29 readings	394° F
,,	pressure in ashpits	$2\frac{3}{8}$ in
,,	vacuum in main flue	1 78 in
,,	in blower boxes	$\frac{1}{4}$ in
,,	in air conduit	·20 in
,,	,, under regenerator	1 40 in
,,	,, over ,,	1 24 in
,,	time taken to clinker one fire	7 min 25 secs
,,	,, between each clinkering	2 hrs 7 min
Number of times each fire clinkered		Three
Damper full open area		10 2 sq ft

Tests B and C are, so far as the writer is aware, record tests, the former being of one month's duration under easy conditions, while the latter being under forced conditions over a short period clearly demonstrates the remarkable elasticity of the plant as also putting on record a remarkable duty for a Lancashire boiler fired with destructor gases

NEWCASTLE ON TYNE MUNICIPAL CORPORATION—POPULATION, 215,328

TWO INSTALLATIONS

	1	2
A	1885	1891
B	Fryer's top fed	Warner's top fed
C	6	6
D	None	None
E	150 feet	Same chimney
F	Natural draught only	—
G	No power available.	
H	75 tons.	—
I	8·16d	

The approximate cost per cell is given at £600 During the

year 1902 a total of 29,536 tons of refuse was dealt with. This is one of the few remaining low temperature installations in this country, and is of course of insufficient capacity for dealing with the total amount of refuse now produced.

S. W.

NEWMARKET URBAN DISTRICT COUNCIL—POPULATION, 10,686

A	Fryer's improved top fed
C	2
D	1 Babcock & Wilcox
E	120 feet
F	Fan
G	Sewage pumping
H	9 tons
I	11*d*

One supplementary boiler of the Cornish type is installed for coal firing as may be found necessary. The clinker is used for road foundation work.

E. W.

NORTHAMPTON MUNICIPAL CORPORATION—POPULATION, 87,021

A	1903
B	Heenan's back fed
C	8
D	2 Lancashire
E	120 feet
F	Fan
G	Electric traction
H	80 tons
I	—

It is proposed to fully utilize the available power for generating electricity for traction purposes, but some few months must yet elapse before this part of the scheme will be complete. The cost of the destructor was £14,150. It is proposed to install a flag plant for partial utilization of the clinker.

Fig. 79 is a cross-section through the boiler, cells and flues, the

chimney, originally arranged to be either 80 or 100 feet in height, was increased in height to 120 feet

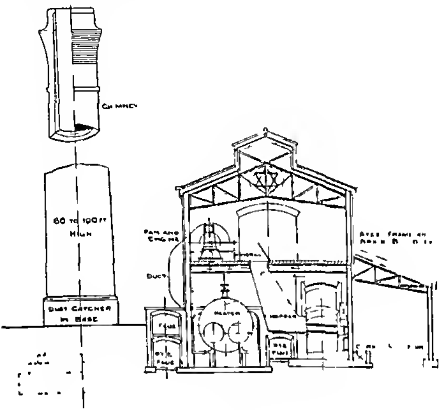

FIG. 79.—NORTHAMPTON COMBINED DESTRUCTOR AND ELECTRICITY WORKS. Cross Section.

S W.

NORWICH MUNICIPAL CORPORATION—POPULATION, 111,728

A	1898 and 1903
B	Horsfall's top fed
C	4
D	2 Babcock & Wilcox
E	100 feet
F	Steam jet blowers
G	Sewage pumping
H	34 tons
I	—

Load factor	12 02 per cent
Fuel cost	71 per unit
Works	1 33
Total	1 75
Net profit	£897

At installation No 2 (Hollinwood) a very complete plant is provided for clinker utilization comprising clinker crushing and mixing machinery and one of Messrs Fielding and Platt's latest three mould type hydraulic flag presses

PADIHAM URBAN DISTRICT COUNCIL—POPULATION, 12 005

A	1901
B	Horsfall's back hand fed
C	3
D	1 Lancashire 28 ft × 7 ft
E	125 ft × 4 ft 6 in internal
F	Steam jet blowers
G	Forced draught and works purposes only
H	12 tons
I	[1]2s 10d

E W

PONTYPRIDD URBAN DISTRICT COUNCIL—POPULATION, 32 310

A Destructor of the Heenan type is now in hand for this Council it is likely that the power will be utilized for electrical purposes The estimated cost of the installation is given as £12 062

PLYMOUTH MUNICIPAL CORPORATION—POPULATION, 107,509

A	1901
B	Warner's top fed
C	12
D	1 Multitubular
E	160 feet
F	Fans
G	—
H	100 tons
I	—

[1] This high figure is attributed to the intermittent operation of the Destructor

Preston Municipal Corporation—Population, 112,989

Three Installations

	No 1 Moor	No 2 Marsh	No 3 E W
A	1886	1892	1903 [1]
B	Fryer's top fed single row	Fryer's top fed back to back	Meldrum's front hand fed
C	8	20	16 grates
D	—	1 Multitubular	4 Lancashire each 30 ft by 8 ft
E	180 feet	250 feet	—
F	Natural draught	—	Steam jet blowers
G	—	—	Electric traction
H	Total 105 tons		80 tons
I	1s 0¼d	11¼d	—

S W

Radcliffe Urban District Council—Population, 25,368

A	1902
B	Meldrum's back hand fed
C	3 grates
D	1 Lancashire 24 ft × 7 ft 6 in
E	150 feet
F	Steam jet blowers
G	Sewage pumping operating sludge presses etc
H	26 tons
I	10d

Ramsgate Municipal Corporation—Population, 27,686

A	1893
B	Horsfall's back hand fed
C	4
D	2 Babcock & Wilcox
E	120 ft × 5 ft internal
F	Steam jet blowers
G	Forced draught and works purposes only
H	20 tons
I	—

[1] This installation will not be completed until late in 1904. It is the largest destructor installation in the world providing power for electrical purposes.

RAWTENSTALL MUNICIPAL CORPORATION—POPULATION, 31 053

A	1902
B	Heenan's back fed
C	2
D	1 water tube
E	—
F	Fan
G	Works purposes only
H	28 tons
I	—

L W

RHYL URBAN DISTRICT COUNCIL—POPULATION, 8 473

A	1902
B	Fryer's improved top fed
C	4
D	2 Babcock & Wilcox
E	120 feet
F	Fan
G	Electric lighting
H	16 tons
I	1s 4d
J	15

Two large Babcock and Wilcox boilers are also provided for supplementary coal firing The power equipment of the station is as follows 3 Compound single acting three crank engines coupled direct to shunt wound multipolar dynamos, the engines being of Messrs Alley & Maclellan's make, and the dynamos of the Lancashire Dynamos Company's make The generating sets have an output of 165 k w at a speed of 380 revolutions per minute a Hart's accumulator battery of 274 cells is also provided

ROCHDALE MUNICIPAL CORPORATION—POPULATION, 83 114

A	1894
B	Meldrum's front hand fed
C	4 grates
D	2 Lancashire, 30 ft × 8 ft
E	250 feet
F	Steam jet blowers

G	Works purposes. About 120 H P
H	40 tons
I	7½*d*

Special interest attaches to this installation, firstly because it was the first Meldrum destructor erected, and secondly because here high pressure steam was first produced from refuse. As observed in another chapter, up to this time (1894) it had been urged that a steam pressure of 60 pounds to the square inch was the highest steam pressure obtainable with refuse as fuel. What Mr Brookman was able to show at Rochdale nine years since has had far reaching effects, in fact it is but fair to say that the demonstration at Rochdale initiated the modern combined plant, because the previously attained low steam pressure was alike useless for electrical purposes or even modern sewage works.

Mr Brookman, Rochdale's well known Cleansing Superintendent and one of the highest authorities on refuse destructors living, has done not a little to popularize final and sanitary disposal. His work has always been of such a thorough and painstaking character that it has contributed in no small measure to our British pre-eminence in this class of work.

Some details of three tests at Rochdale are here given, and they are worthy of careful perusal. (See Table, page 292.)

In addition to the destructor at Rochdale, 5 large Cornish boilers are provided; these are equipped with Meldrum forced draught furnaces, and burn a considerable quantity of refuse, the power from which is also fully utilized in connection with sanitary manure plant.

Rhondda Urban District Council—Population 117,000

A	1900
B	Mason's gasifier
C	2
D	1 vertical.
E	—
F	Steam jet blowers
G	Not available
H	16 tons.
I	2*s* 7*d*.

ROCHDALE DESTRUCTOR

TEST MADE AT THE CORPORATION SANITARY WORKS

Under the supervision of F. W. Brookman, Esq., Resident Engineer

Date of test	Mar. 1, 1895	Nov. 14, 1895	Nov. 15, 1895
Duration of test	6 hours	6¼ hours	6½ hours
Total refuse destroyed	11.4 tons	13.75 tons	14.3 tons
Refuse burnt per hour	4,256 lb.	4,738 lb.	4,945 lb.
Refuse burnt per hour, per square foot of grate	47.3	52.6	54.9 ,,
Water evaporated per lb. of refuse	1.64	1.39	1.47 ,,
Equivalent evaporation, from and at 212°	1.97	1.68	1.78
Number of boilers used	Two	One	One
Temperature of feed water	53° F.	52° F.	52° F.
Total water evaporated	42,072 lb.	42,900 lb.[1]	47,400 lb.[1]
Water evaporated per hour	7,012 ,,	6,600	7,290 ,,
Equivalent evaporation, from and at 212° F.	8,431	7,980	8,820 ,,
Average steam pressure per square inch	117	113	114 ,,
Percentage of (CO^2) in products of combustion	15.9	—	—
Percentage of (CO) in products of combustion	Nil	—	—
Percentage of free oxygen	2.2	—	—
Labour cost per ton of refuse destroyed	7½d.	—	—

[1] It was found that some heat passed the damper and evaporated 60 and 54 gallons of water per hour respectively, in the stand-by boiler; these items were therefore included in the above figures.

ROTHERHAM MUNICIPAL CORPORATION—POPULATION, 54,348

A	1892
B	Fryer's top fed
C	6
D	[1] 1 Multitubular, 14 ft × 7 ft
E	130 feet
F	Steam jet blowers
G	Works purposes only
H	40 tons
I	1s 0½d

ROYTON URBAN DISTRICT COUNCIL POPULATION 14,881

A	1903
B	Warner's top fed
C	4
D	1 Multitubular, 12 ft × 7 ft
E	213 feet
F	Natural draught only
G	—
H	20 tons
I	9½d

ST ANNE'S ON SEA URBAN DISTRICT COUNCIL—POPULATION, 6 807

A	1900
B	Warner's top fed
C	2
D	1 Multitubular
E	—
F	Fan
G	Forced draught and works lighting only
H	6 tons normally
I	1s 4 1d

E W.

ST HELENS MUNICIPAL CORPORATION—POPULATION, 87,3[illegible]

A	1899
B	Meldrum's Beaman & Deas top fed
C	4

[1] It has recently been decided to install a [illegible]

D	**2 Babcock & Wilcox**
E	**200 feet**
F	**Fan**
G	**Electric traction**
H	**32 tons**
I	**1s 2d**

The steam ranges from the destructor boilers to the engine room are so designed that two sets of each 125 k w can be run from the destructor boiler independently of the other boilers or the destuctor boilers and supplementary coal fired Lancashire boilers can supply the whole range in parallel

In each machine circuit a watt hour recorder meter is fixed to meter the output from the generator The usual practice is to drive one or both of the 125 k w sets from the destructor only for a part of the day and later on when more plant is required to parallel both sets of boilers on the whole load

Some figures extracted from the returns for the first year's working from March 31st 1900 to March 31st 1901 are of interest —

	Total for one Year	Average per Week
Weight of refuse destroyed	9 778 tons	188 tons
Electrical energy used for driving fan and other motors	70 000 units	1 346 units
Units generated by destructor boilers	365 000 units	7 019 units
Wages	£750	£14 8s 6d
Weight of clinker produced	3 900 tons	75 tons
Value of mortar sold	£221 9s 8d	£4 5s 2d
Value of electrical units generated at ·3d per unit	£450	£8 13s 1d

AVERAGES PER TON OF REFUSE DESTROYED

Units generated exclusive of power used for 2 mortar mills and 1 steam winch	37·3
Units used on works	7·1

A few figures taken from the analysis of the accounts for the year ending March 31st 1902 are interesting—

Labour factor	17.84 per cent
Fuel cost per unit	.26*d*
Works cost per unit	.[illegible]5*d*
Total	1.04*d*
Net surplus for year	£261

Four supplementary coal fired boilers of the Lancashire type are provided and the power equipment of the works is as follows

6 Willans' engines total H.P. 2,220, and 6 multipolar dynamos direct coupled, total capacity 1,340 k.w., also a storage battery of 730 *Chloride cells R type*

Some details of the official test of the destructor are here given—

Date of test	April 10, 1900
Duration of test (10.30 a.m. to 5.50 p.m.)	7 hours 20 mins.
State of the weather	Fine, windy
Kind of fuel burned	Unscreened ashpit refuse
Total weight of fuel burned	16 tons 18 cwt. 2 qrs. = 37,912 lb.
Weight burned per hour	5,169 lb.
Weight burned per sq. ft. of grate area (50 sq. ft.)	103 lb.
Total weight of clinker and ash	5 tons 6 cwt. 1 qr. = 11,900 lb.
Percentage of clinker and ash	31.36 per cent
Total water evaporated	48,216 lb.
Water evaporated per hour	6,575 lb.
" per lb. of refuse actual	1.27 lb.
" per lb. of refuse from and at 212° F. including economiser	1.74 lb.
Temperature of water in tanks	40° F.
" of feed water from economiser	190° F.
Average steam pressure	132 lb.
" air pressure under grates	3.1 in.
Temperature in combustion chamber, by copper test	2,000° F.
Temperature in main flue before economiser	537° F.
" " after economiser	3[illegible]8° F.
Percentage of CO_2 average for 21 readings	10.4 per cent
" O " " 20 "	9.16 " "

D	2 Babcock & Wilcox
E	200 feet
F	Fan
G	Electric traction
H	32 tons
I	1s 2d

The steam ranges from the destructor boilers to the engine room are so designed that two sets of each 125 k w can be run from the destructor boiler independently of the other boilers, or the destuctor boilers and supplementary coal fired Lancashire boilers can supply the whole range in parallel

In each machine circuit a watt hour recorder meter is fixed, to meter the output from the generator The usual practice is to drive one or both of the 125 k w sets from the destructor only for a part of the day, and later on, when more plant is required, to parallel both sets of boilers on the whole load

Some figures extracted from the returns for the first year's working from March 31st 1900, to March 31st, 1901, are of interest—

	Total for one Year	Average per Week
Weight of refuse destroyed	9 778 tons	188 tons
Electrical energy used for driving fans and other motors	70,000 units	1,346 units
Units generated by destructor boilers	365 000 units	7,019 units
Wages	£750	£14 8s 6d
Weight of clinker produced	3 900 tons	75 tons
Value of mortar sold	£221 9s 8d	£4 5s 2d
Value of electrical units generated at 3d per unit	£450	£8 13s 1d

AVERAGES PER TON OF REFUSE DESTROYED

Units generated exclusive of power used for 2 mortar mills and 1 steam winch	37 3
Units used on works . .	7 1

A few figures taken from the analysis of the accounts for the year ending March 31st, 1902, are interesting—

Labour factor	17 84 per cent
Fuel cost per unit	26*d*
Works cost per unit	65*d*
Total ,, ,, ,,	1 04*d*
Net surplus for year	£261

Four supplementary coal fired boilers of the Lancashire type are provided and the power equipment of the works is as follows . 6 Willans' engines, total H P 2 220, and 6 multipolar dynamos direct coupled total capacity 1,310 k w , also a storage battery of 730 Chloride cells R type

Some details of the official test of the destructor are here given—

Date of test	April 10, 1900
Duration of test (10 30 a m to 5 50 p m)	7 hours 20 mins
State of the weather	Fine, windy
Kind of fuel burned	Unscreened ashpit refuse
Total weight of fuel burned	16 tons 18 cwt 2 qrs = 37,912 lb
Weight burned per hour	5,169 lb
Weight burned per sq ft of grate area (50 sq ft)	103 lb
Total weight of clinker and ash	5 tons 6 cwt 1 qr = 11,900 lb
Percentage of clinker and ash	31 30 per cent
Total water evaporated	48 216 lb
Water evaporated per hour	6 575 lb
,, ,, per lb of refuse, actual	1 27 lb
,, ,, per lb of refuse, from and at 212° F , including economiser	1 54 lb
Temperature of water in tanks .	46° F.
,, of feed water from economiser	190° F.
Average steam pressure .	132 lb
,, air pressure under grates .	3 1 in
Temperature in combustion chamber, by copper test .	2,000° F.
Temperature in main flue, before economiser	537° F.
,, ,, ,, after economiser	338° F.
Percentage of CO_2, average for 21 readings	10 4 per cent
,, O, ,, ,, 20 ,, .	9 16 ,,

D	2 Babcock & Wilcox
F	200 feet
F	Fan.
G	Electric traction
H	32 tons
I	1s 2d

The steam ranges from the destructor boilers to the engine room are so designed that two sets of each 125 k w can be run from the destructor boiler independently of the other boilers or the destuctor boilers and supplementary coal fired Lancashire boilers can supply the whole range in parallel

In each machine circuit a watt hour recorder meter is fixed to meter the output from the generator The usual practice is to drive one or both of the 125 k w sets from the destructor only for a part of the day and later on, when more plant is required to parallel both sets of boilers on the whole load

Some figures extracted from the returns for the first year's working from March 31st 1900, to March 31st, 1901, are of interest—

	Total for one Year	Average per Week
Weight of refuse destroyed	9 778 tons	188 tons
Electrical energy used for driving fans and other motors	70 000 units	1 346 units
Units generated by destructor boilers	365 000 units	7 019 units
Wages	£750	£14 8s 6d
Weight of clinker produced	3 900 tons	75 tons
Value of mortar sold	£221 9s 8d	£4 5s 2d
Value of electrical units generated at 3d per unit	£450	£8 13s 1d

Averages per Ton of Refuse Destroyed

Units generated exclusive of power used for 2 mortar mills and 1 steam winch	37.3
Units used on works	7.3

A few figures taken from the analysis [illegible] year ending March 31st 1902 are interesting [illegible]

Labour factor	[illegible]
Fuel cost per unit	[illegible]
Works cost per unit	[illegible]
Total	[illegible]
Net surplus for year	[illegible]

Four supplementary coal fired boilers of the [illegible] are provided and the power equipment of the [illegible] 6 Willans' engines total H P 2 220, and [illegible] direct coupled total capacity 1 310 k w , also a storage battery of 730 Chloride cells R type

Some details of the official test of the destructor are [illegible] given—

Date of test	April 10, [illegible]
Duration of test (10 30 a m to 5 [illegible] p m)	7 hours [illegible]
State of the weather	Fine, windy
Kind of fuel burned	[illegible]
Total weight of fuel burned	16 tons 18 cwt [illegible] 37 912 lb
Weight burned per hour	5 1[illegible] lb
Weight burned per sq ft of grate area ([illegible]0 sq ft)	107 lb
Total weight of clinker and ash	5 tons [illegible] cwt [illegible] qr = 11 900 lb
Percentage of clinker and ash	31 36 per cent
Total water evaporated	48 21[illegible] lb
Water evaporated per hour	[illegible] 575 lb
" per lb of refuse actual	1 27 lb
" per lb of refuse from and at 212° F including economiser	1 54 lb
Temperature of water in tanks	4[illegible]° F
" of feed water from economiser	190° F
Average steam pressure	132 lb
" air pressure under grates	3 1 in.
Temperature in combustion chamber, by copper test	2 000° F
Temperature in main flue before economiser	537° F
" " after economiser	358° F
Percentage of CO_2 average for 21 readings	10 4 per cent
" O_2 " " 20 "	9 16 " "

Great credit is due to the late chief engineer, Mr J S Highfield for the very excellent results obtained at this combined works which must rank as one of the most successful in this country

St Heliers, Jersey

A	1899
B	Horsfall's back hand fed
C	3
D	1 Babcock & Wilcox
F	75 ft × 4 ft 6 in internal
J	Steam jet blowers
G	Forced draught only
H	15 tons
I	—

During the first few months of working nuisance was caused by the escape of offensive dust and fumes and litigation ensued This trouble was no doubt seriously contributed to by careless working and lack of efficient supervision

Salford Municipal Corporation—Population, 220 957

Five Installations

	No 1 Wilburn St	No 2 Agecroft	No 3 Carey St	No 4 Wilburn St	No 5 Carey St
A	1883	1888	1888	1902	1902
B	Fryer's modified top fed	Fryer's modified top fed	Fryer's modified top fed	Warner's top fed	Warner's top fed
C	12	6	6	3	6
D	1 Multitubular	—	—	1 Lancashire	3 Multitubular
F	180 ft	180 ft	180 ft	same	chimney
J	Natural	draught	only	Fan	Fan
G	—	—	—	Forced draught works	and purposes
H	—	—	—	—	—
I	—	—	—	—	—

S W

SALISBURY MUNICIPAL CORPORATION—POPULATION 17 117

A	1907
B	Horsfall s back hand fed
C	
D	2 Babcock & Wilcox
E	L.0 ft × ft internal
F	St am j t blowers
G	Sewage pumping
H	10 tons
I	Is 3d

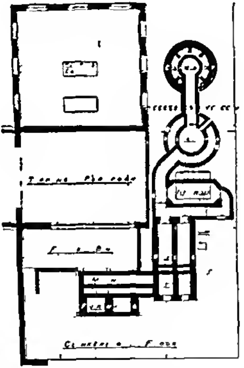

FIG 80 SALISBURY COMBINED DESTRUCTOR AND SEWAGE WORKS Plan

The general arrangement of this installation will be seen by referring to Fig 80 This destructor, being part of a modern scheme is very complete, and an excellent example of its type

Some interesting details of an evaporative test conducted by the National Boiler Insurance Co Ltd are here given—

TEST OF A TWO CELL HORSFALL DESTRUCTOR, CARRIED OUT BY THE NATIONAL BOILER INSURANCE COMPANY, LIMITED, AT SALISBURY FOR THE SALISBURY URBAN SANITARY AUTHORITY, APRIL 16TH AND 17TH, 1902

GENERAL PARTICULARS

DESTRUCTOR.—With two cells Horsfall's back fed type each furnace having 30 square feet grate area Worked under forced draught

BOILERS.—Two Babcock and Wilcox boilers set in one battery Each drum 3 feet diameter 23 feet 7½ inches long with 40 tubes 18 feet long Fired by the waste gases from the Destructor Total heating surface of both boilers 1 800 square feet

ECONOMISER.—One Green's economiser of 72 pipes Total heating surface 720 square feet

SCHEDULE OF PRINCIPAL RESULTS

Line	Guarantees			Results Obtained		
A—Total refuse to be destroyed	20 tons in 23 hours			20 tons in 19½ hours		
B—Refuse to be burnt per sq ft of grate per hour	32 lb			39 2 lb		
C—Total evaporation of steam	40 000 lb in 23 hrs			43 645 3 lb in 19½ hrs		
D—Water evaporated per lb of refuse destroyed from and at 212° F	1 lb			1 23 lb		
	Max	Min	Aver	Max	Min	Aver
E—Boiler pressure—lb per sq in	110	100	—	134	130	133
F—Temperature of feed water leaving economiser deg F	2[illegible]0	2[illegible]0	—	220	191	214
G—Temperature in furnace deg F	1 800	1 200	1 500	2 000	[illegible]	[illegible]
				Taken in combustion chamber		

	Guarantees	Results Obtained		
		Max	Min	Aver
H—Temperature deg F in main flue at inlet to No 1 boiler	About 1 600° F	1 503	1 120	1 313
I—Temperature deg F in main flue at inlet to No 2 boiler	About 1 400° F	1 373	810	[illegible]

OTHER OBSERVATIONS

J—Temperature of flue gases
K—Temperature of flue gases
L—Average temperature of water
M—Percentage of clinker
N—Weather

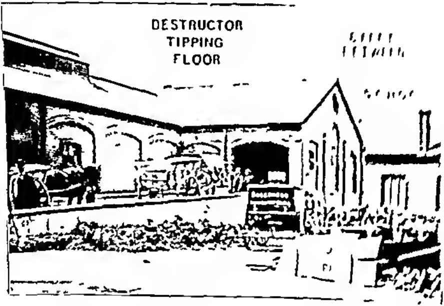

FIG 81 SHEERNESS COMBINED DESTRUCTOR AND WATER WORKS
View of Inclined Roadway and Building

W W

SHEERNESS URBAN DISTRICT COUNCIL—POPULATION 14 402

A	1903
B	Meldrum s front hand fed
C	2 grates
D	1 Lancashire 26 ft × 7 ft
F	90 feet
1	Steam jet blowers
G	Water pumping
H	10 tons
I	1s

Figs. 81, 82 and 83 illustrate this plant, which is of more than ordinary interest. It is combined with the Council's water works on a remarkably central site. Sufficient power is obtained to operate the deep well pumps (about 70 H.P.) with the exception of Sundays, when, there being no collection of refuse, coal is used in a separate boiler.

Fig. 81.—Sheerness Combined Destructor and Water Works. View of Cells.

The total cost of the installation was about £3,500, and up to the present time, after six months' working, the average saving in fuel and collection cost has been over £17 per week.

It is anticipated that at the end of twelve months' working a saving of £1,000 will have been effected, and that the net economy as the result of the combination will be at least £600 per annum.

The external view of the works (Fig. 83) clearly conveys their remarkably central location. The chimney, 90 feet in height, was previously used for the coal fired boilers, and while being then

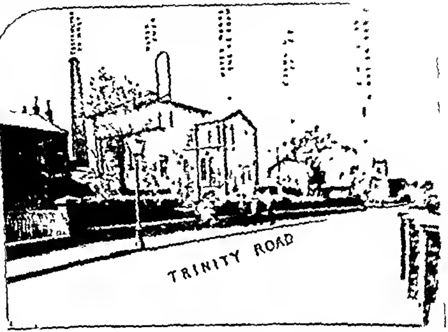

FIG 83 SHEERNESS COMBINED DESTRUCTOR AND WATER WORKS
View showing the Large Chimney of the Works

notorious owing to the emission of black smoke, is now quite free from offence

SHEFFIELD MUNICIPAL CORPORATION—POPULATION 410,993
TWO INSTALLATIONS

	I Lumley Street	II[1] Penistone Road
A	1897 and 1901	1901
B	Warner's top fed	Horsfall's top fed
C	16 cells	12 cells
D	2 Multitubular	2 Lancashires
E	180 feet	—
F	Fan	Steam jet blowers
G	Forced draught and works purposes	Forced draught and works purposes
H	100 tons	100 tons
I	11½d	—

[1] Works not yet in operation

In connection with installation No 1, 2 mortar mills and a Musker hydraulic flag plant are provided, and a complete clinker utilization plant is being provided at Penistone Road destructor

E W S W

SHIPLEY URBAN DISTRICT COUNCIL—POPULATION, 26 000

A	1901
B	Meldrum s front hand fed
C	4 grate

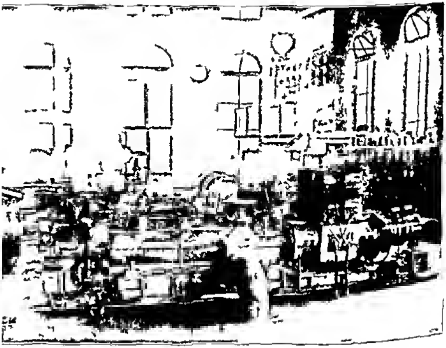

FIG 84 SHIPLEY COMBINED DESTRUCTOR AND ELECTRICITY WORKS
View of Engine-room and Turbo Generators

D	1 Lancashire 30 ft × 8 ft
E	180 feet
F	Steam jet blowers
G	Electric lighting, traction and sewage pumping
H	25 tons
I	10½ %
J	40

In addition to supplying power for operating electrically driven sewage pumps the destructor also gives a considerable amount of power, which is mainly used for the day load motors and traction

During the year ending March 31, 1903 92542 units were used in the works for sewage pumping, works lighting clinker crushing, etc, the total station costs being 1 368*d* per unit and the fuel cost 372*d* per unit

Two supplementary Lancashire boilers are installed for coal firing, and the power equipment of the station comprises 3 Parson's turbines, total capacity 720 k w, and a storage battery of 260 B P T and L Company York cells

Fig 84 is a view of the engine room showing the whole of the generating plant as also the switchboards

SMETHWICK—POPULATION, 51,530

A	—[1]
B	Meldrum's improved top fed
C	6 grates
D	1 Lancashire
E	150 feet
F	Steam jet blowers
G	Not yet decided
H	55 tons

About three years since a Mason's gasifier (2 cells) was erected, but this has not been used for some time past

S W

SOUTHAMPTON MUNICIPAL CORPORATION—POPULATION, 107,833

TWO INSTALLATIONS

	1	2
A	1887	1901
B	Fryer's top fed	Fryer's improved top fed
C	6	4
D	1 Multitubular	2 Babcock & Wilcox

[1] This installation, which is estimated to cost £9 000, will not be completed until late in 1904

E	160 feet	Same chimney
F	—	Fan
G	—	Sewage pumping
H	30 tons	40 tons
I	—	1s 2½d

The available power from installation No 2 is fully utilized for sewage pumping the dry weather flow being 4 000 000 gallons per 24 hours the height of the lift is 18 feet

SOUTHPORT MUNICIPAL CORPORATION—POPULATION, 48 083

A	1901
B	Horsfall's top fed
C	6
D	1 Lancashire 30 ft × 8 ft
E	180 ft × 7 ft internal
F	Steam jet blowers
G	Gas works
H	40 tons
I	1s 2d

SOUTHWOLD MUNICIPAL CORPORATION—POPULATION, 2 800

A	1900
B	Ball's patent
C	1
D	None
E	—
F	Natural draught only
G	No power available
H	2 tons
I	—

S W

STAFFORD MUNICIPAL CORPORATION—POPULATION, 20 894

A	1898
B	Fryer's improved top feed
C	4
D	2 Babcock & Wilcox
E	135 feet
F	1 in
G	Sewage pumping
H	20 tons
I	1s 4d

The cost of the destructor and accessories, but exclusive of buildings and chimney, was £2,315

STOCKTON-ON-TEES MUNICIPAL CORPORATION—POPULATION, 51,478

A	1901
B	Horsfall's back hand fed
C	2
D	Babcock & Wilcox
E	130 ft. × 4 ft. internal
F	Steam jet blowers
G	Clinker crusher and mortar mill
H	20 tons
I	9d

Six cells would be necessary to deal with the present collection of refuse, the bulk of which is still being tipped or disposed of to farmers

The capital expenditure on the present plant was £3,091, exclusive of the cost of the site and included roadway, this being estimated at £700 The future extensions are estimated to cost £1,000 per cell

E W

STOKE-ON TRENT MUNICIPAL CORPORATION
POPULATION, 30,800

A	1903[1]
B	Meldrum's front hand fed
C	6 grates
D	2 Lancashire, 30 ft. × 8 ft.
E	120 feet
F	Steam jet blowers
G	Electric lighting
H	30 tons
I	.

STOURBRIDGE URBAN DISTRICT COUNCIL
POPULATION, 16,302

It has recently been decided to erect a destructor of the Horsfall type at a cost of £3,750

[1] Now in course of erection

STRETFORD URBAN DISTRICT COUNCIL—POPULATION, 30,436

A	1899
B	Meldrum's Beaman & Deas top fed
C	2
D	1 Babcock & Wilcox
E	150 feet
F	Fan
G	Works purposes only
H	18 tons
I	1s 4d

S W

SUDBURY MUNICIPAL CORPORATION—POPULATION, 7,109

A	1903
B	Meldrum's front hand fed
C	4 grates
D	2 Cornish 15 ft × 5 ft
E	80 feet
F	Steam jet blowers
G	Sewage pumping
H	5 tons
I	—

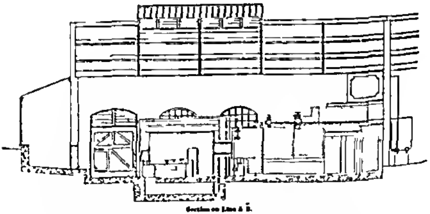

FIG 85 SUDBURY COMBINED DESTRUCTOR AND SEWAGE WORKS

This installation is of interest as being the smallest combined plant of the kind yet erected in this country As such it affords a striking object lesson as to what may be done with such a

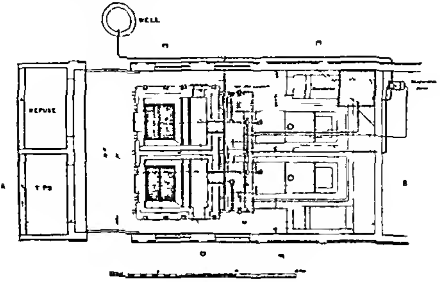

FIG 86

SUDBURY COMBINED DESTRUCTOR AND SEWAGE WORKS

small quantity of refuse The clinker will be fully utilized for the bacteria beds

The general arrangement of the destructor is shown in Figs 85 and 86, and it will be observed that although only a small plant, it is yet complete in every respect

SWANSEA MUNICIPAL CORPORATION—POPULATION 94 615

An eight cell destructor of Horsfall s top fed type is now in hand, the estimated cost of the same being £9 600

S W

TAUNTON MUNICIPAL CORPORATION—POPULATION, 21,078

A	1903
B	Horsfall s back hand fed
C	4
D	2 Babcock & Wilcox.
E	75 feet
F	Steam jet blowers
G	Sewage pumping
H	20 tons
I	—

Fig. 87 is an external view of the works. The centrifugal

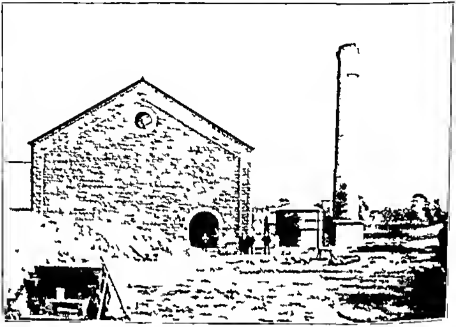

Fig. 87.—Taunton Combined Destructor and Sewage Works: Exterior View showing Dust Catcher.

dust catcher will be observed between the building and the chimney.

Torquay Municipal Corporation—Population, 33,62[illegible]

A	1899
B	Warner's top fed
C	4
D	2 Multitubular
E	1[illegible]0 feet
F	Fan
G	Works purposes only
H	25 tons
I	[1]9[illegible]d

These works are situated in a hollow, and for the first year or two of operation the complaints concerning nuisance from escaping fumes were numerous and apparently well founded.

[1] This is a test figure.

Experts were, however, consulted by the Corporation and the alterations suggested and adopted have had the effect of avoiding further trouble

E W

TOTTENHAM URBAN DISTRICT COUNCIL POPULATION 106 500

A	1903
B	[illegible] top fed
C .	10
D	[illegible]
E .	180 feet
F	Fans
G .	Electric lighting
H	60 tons
I .	

Fig 88 is a block plan showing the general arrangement of this plant, it will be observed that each cell is provided with a separate fan for forced draught this is a new departure and while offering some advantages over the usual practice yet cannot on the whole be recommended

E W , S W

WAKEFIELD MUNICIPAL CORPORATION—POPULATION, 41 511

TWO INSTALLATIONS

	1	2
A	1898	1902
B	Fryer's improved top fed	Heenan's back fed
[1] C	4	2
D	2 Babcock & Wilcox	1 Lancashire 21 ft × 7 ft
E	—	
F	Fan	Fan
G	Electric lighting and sewage pumping	
H	Total 40 tons	

Five supplementary coal fired boilers are installed these being of the Lancashire type each 30 long and 8 in diameter The

[1] Works not yet in operation

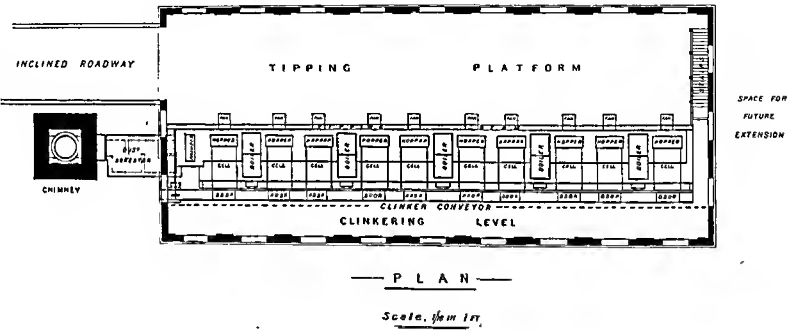

FIG 88 TOTTENHAM DESTRUCTOR

power equipment of the station is as follows 3 Horizontal slow speed engines total H P 450 3 fly wheel alternators, 112 k w each and 2 400 k w high speed vertical engines

The Sanitary Committee pay the Electricity Committee 1s 6d per ton of refuse destroyed, the Electricity Committee providing 40 H P for operating the pumps for lifting the sewage into the settling tanks

Some details of a test carried out with Installation No 2 soon after its completion are here given—

Date of test	July 12 1902
Number of cells in use	2
Total grate area	50 square feet
Refuse consumed per hour	2 230 lb
Refuse consumed per sq ft of grate surface per hour	44 6 lb
Total water evaporated per hour	3080 lb
Water evaporated per lb of refuse destroyed from and at 212° F	1 4 lb

WALLASEY URBAN DISTRICT COUNCIL—POPULATION, 55,000

A	1897
B	Fryer s improved
C	6
D	No boilers
E	160 feet
F	Natural draught only
G	No power available
H	40 tons
I	11*d*

WALKER ON TYNE URBAN DISTRICT COUNCIL—
POPULATION, 13 335

A	1902
B	Meldrum s front hand fed
C	*8 grates*
D	2 Cornish each 15 ft × 6 ft 6 in
E	90 feet
F	Steam jet blowers
G	Works purposes only
H	30 tons
I	6¾*d*

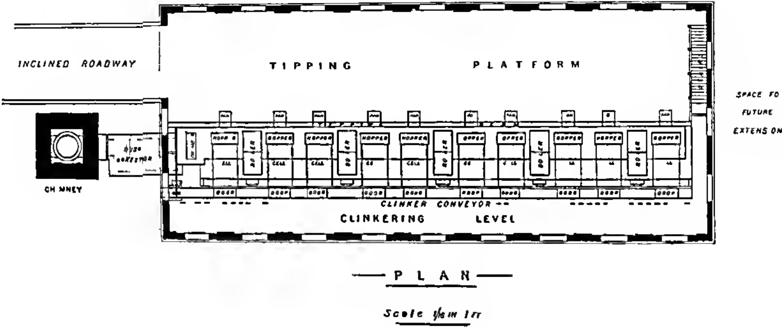

FIG 98 TOTTENHAM DESTRUCTOR

power equipment of the station is as follows [illegible] speed engines, total H P 450 3 fly wheel [illegible] each, and 2 400 k w high speed vertical [illegible]

The Sanitary Committee pay the [illegible] 1s 6d per ton of refuse destroyed the [illegible] providing 40 H P for operating the [illegible] sewage into the settling tanks

Some details of a test carried out with Installation [illegible] after its completion are here given —

Date of test	[illegible]
Number of cells in use	[illegible]
Total grate area	[illegible]
Refuse consumed per hour	[illegible]
Refuse consumed per sq ft of grate surface per hour	[illegible]
Total water evaporated per hour	[illegible]
Water evaporated per lb of refuse destroyed from and at 212° F	[illegible]

WALLASEY URBAN DISTRICT COUNCIL—POPULATION, 55 000

A	1897
B	Fryer's improved
C	[illegible]
D	No boilers
E	160 feet
F	Natural draught only
G	No power available
H	40 tons
I	11d

WALKER-ON-TYNE URBAN DISTRICT COUNCIL—POPULATION, 13 335

A	1902
B	Meldrum's front hand fed
C	8 grates
D	2 Cornish each 15 ft × 6 ft 6 in
E	90 feet
F	Steam jet blowers
G	Works purposes only
H	30 tons
I	6½d

The details of the official test here given will serve to emphasize the serious mistake, even now frequently made, of not combining the destructor with some works where the power can be fully utilized

Date	Nov 25 1902
Time commenced	9 30 a m
Time finished	8 20 p m
Duration of test	10 hours 50 min
Grate area	100 square feet
Quantity of refuse destroyed 30 tons 16 cwt 1 qr	69 020 lb
Quantity of refuse destroyed per sq ft of grate area per hour	64 lb
Residue—Clinker 7 tons 9 cwt 2 qr	
Ashes 0 „ 11 „ 0	17,076 lb
Percentage of clinker	26 per cent
Temperature of combustion chamber—Melted nickel 5 times Fused and melted ¼ in chain 4 times Melted copper when cleaning out	
Approximate maximum temperature	3 000° F
Average temperature	Over 2 000° F
Average temperature in side flue at back of setting	Over 1,400° F
Average temperature in side flue with combustion chamber door open	1,310° F
Average temperature in bye pass at entrance, with air inlets open	950° F
Average temperature in bye pass with combustion chamber cleaning door open	875° F
Average temperature in flue before regenerator	775° F
Average temperature at chimney base	260° F
Ashpit pressure	1¾ in
Pull before regenerator	⅝ in
Pull after regenerator	⅜ in
Pull in bye pass	⅞ in
Average steam pressure	90 lb

HANDCOCK & DYKES Consulting Engineers
1, Victoria Street Westminster, S W

Nov 29 1902

NOTE —It is worthy of remark that the occasion of the Walker test is the first on record where ¼ inch steel chain was fused and melted in the combustion chamber of a destructor furnace

It will be observed that this official test was carried out to determine whether or not the Destructor could fulfil the guar

anteed destroying capacity, but the figures are useful for other purposes clearly showing as they do that a temperature can be reached and maintained such as was deemed impossible a few years since

The following extract from the consulting engineer's report is of interest clearly showing the serious loss in the case in question owing to the destructor not being combined with the electricity works—

With the result of the test we are exceedingly pleased as the plant has in every respect exceeded the requirements that we specified and is working in a most satisfactory manner there being no offensive gases given off either from the chimney or the furnaces and there is almost an entire absence of smoke It seems however a great pity to an engineer or indeed to any one of an economical turn of mind to see so much valuable power being wantonly thrown away as the present plant has no arrangement for steam raising on a large scale We were unable to test the amount of water which could be evaporated per ton of refuse but from our experience of other destructors and heat obtained in the furnaces we have no hesitation in asserting that if suitable boilers were installed each pound of refuse burnt in the destructor would provide 1½ lbs of high pressure steam over and above that required for the steam jets etc Now each unit burns 2 9 tons of refuse per hour thus furnishing practically 10 000 lbs of steam per hour and allowing say 20 lbs of steam per horse power per hour would give 500 horse power which is considerably more than the power required to do all the lighting in Walker and supplying the trams in addition This is a sufficient answer to the critics who questioned the original proposals submitted namely to work the machinery in your proposed electric lighting station entirely by the heat provided by the refuse destructor

At the present time actually 500 horse power is being wasted for 12 hours per day and it certainly seems a pity that as the supply company have to keep men at the destructor and also men and machinery in their sub station that they could not utilize this heat by putting down steam engines alongside the destructor as provided in our original plans thus saving the coal required for 500 horse power

Warrington Municipal Corporation—Population, 64,242
Two Installations

	1	2 F W
A	1896	1901
B	Meldrum s Beaman & Deas top fed	Meldrum s Beaman & Deas top fed
C	4	4

The details of the official test here given will serve to emphasize the serious mistake, even now frequently made, of not combining the destructor with some works where the power can be fully utilized

Date	Nov 25 1902
Time commenced	9 30 a m
Time finished	8 20 p m
Duration of test	10 hours 50 min.
Grate area	100 square feet
Quantity of refuse destroyed 30 tons 16 cwt 1 qr	69 020 lb
Quantity of refuse destroyed per sq ft of grate area per hour	64 lb
Residue—Clinker 7 tons 9 cwt 2 qr; Ashes 0 11 , 0	17,976 lb
Percentage of clinker	26 per cent
Temperature of combustion chamber—Melted nickel 5 times Fused and melted ½ in chain 4 times Melted copper when cleaning out	
Approximate maximum temperature	3,000° F
Average temperature	Over 2 000° F
Average temperature in side flue at back of setting	Over 1,400° F
Average temperature in side flue with combustion chamber door open	1 310° F
Average temperature in bye pass at entrance with air inlets open	950° F
Average temperature in bye pass with combustion chamber cleaning door open	875° F
Average temperature in flue before regenerator	775° F
Average temperature at chimney base	260° F
Ashpit pressure	1¼ in
Pull before regenerator	⅜ in
Pull after regenerator	¾ in
Pull in bye pass	¼ in
Average steam pressure	90 lb

HANDCOCK & DYKES Consulting Engineers
1, Victoria Street, Westminster, S W

Nov 29, 1902

NOTE —It is worthy of remark that the occasion of the Walker test is the first on record where ½ inch steel chain was fused and melted in the combustion chamber of a destructor furnace

It will be observed that this official test was carried out to determine whether or not the Destructor could fulfil the guar

anteed destroying capacity, but the figures are useful for other purposes, clearly showing as they do that a temperature can be reached and maintained such as was deemed impossible a few years since

The following extract from the consulting engineer's report is of interest, clearly showing the serious loss in the case in question owing to the destructor not being combined with the electricity works—

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At the present time actually 500 horse power is being wasted for 12 hours per day and it certainly seems a pity that as the supply company have to keep men at the destructor and also men and machinery in their sub station that they could not utilize this heat by putting down steam engines alongside the destructor as provided in our original plans thus saving the coal required for 500 horse power

WARRINGTON MUNICIPAL CORPORATION—POPULATION, 64 242
TWO INSTALLATIONS

	1	2 E W
A	1896	1901
B	Meldrum s Beaman & Deas top fed	Meldrum s Beaman & Deas top fed
C	4	4

D	2 Babcock & Wilcox	2 Babcock & Wilcox
E	120 feet	—
F	Fan	Fan
G	Sanitary manure works	Electric lighting
H	30 tons	34 tons
I	1s 1½d	1s 2d
J	—	80

Installation No 1 was the first of its type in this country, at Installation No 2 the works cost per unit generated in mid winter when the refuse is of the highest calorific value is given as ·825d per unit This figure includes salaries and all incidental charges, but is exclusive of interest and sinking fund

Four coal fired supplementary boilers of the Babcock and Wilcox type are provided and the power equipment of the station is as follows 4 Willans' engines total H P 1760, direct coupled to 3 Bruce-Peebles' four pole dynamos, and 1 E E M Company's dynamo total capacity 1,100 k w 262 Chloride cells are also installed the capacity of the same being 800 ampère hours

S W

WATFORD URBAN DISTRICT COUNCIL—POPULATION, 29 023

A	1903
B	Meldrum's front hand fed
C	4 grates
D	1 Lancashire, 30 ft × 8 ft
E	170 feet (Custodis type)
F	Steam jet blowers
G	Sewage pumping
H	40 tons
I[1]	—

E W

WELLINGBOROUGH URBAN DISTRICT COUNCIL—POPULATION, 18 142

A	1900
B	Mason's top fed
C	1
D	1 Stirling water tube
E	100 feet

[1] These works are not yet in operation

F	Steam jet blowers
G	Forced draught and electric lighting
H	12 tons

S W
West Bridgford Urban District Council—Population, 7 018

A	1903
B	Warner s top fed
C	2
D	1 Multitubular
E	160 feet
F	Fan
G	Sewage pumping
H	7 tons

E W
West Hartlepool Municipal Corporation—Population, 62 627

Two Installations

	1	2
A	1901	1903 [1]
B	Horsfall s top fed	Horsfall s top fed
C	6	6
D	2 Babcock & Wilcox	1 Babcock & Wilcox marine type
E	—	—
F	Steam jet blowers	Steam jet blowers
G	Electric lighting and works purposes	
H	60 tons	
I	[2] 10½d	

About 80 H P is supplied to the electricity works from Installation No 1 power being also used for operating a clinker crusher and mortar mill the mortar sells freely at 7s 6d per ton

The capital cost of this plant was £7 646 exclusive of the cost of the site but including the sum of £1 000 as part cost of the chimney, which is also used for the supplementary coal fired boilers

[1] Now in course of erection

[2] This figure applies to a test

Three Lancashire boilers are provided for coal firing and the power equipment of the station comprises the following 6 Bellis compound high speed engines direct coupled to 7 Crompton two pole shunt wound dynamos total capacity 500 k w and a storage battery of 260 Tudor cells capacity 300 ampere hours

Some details of an evaporative test in connection with the destructor are here given—

Date of test	January 17 to 18 190?
Duration of test (started from cold)	24 hours —1 day
Number and type of cell	C cell back to back top fed.
Total grate surface	180 square feet
System of forced draught . .	Horsfall Co s patent steam blowers
Nature of refuse	Ash pit house and market
Number and type of boilers	2 water tube
Total quantity of refuse burned	5? tons 3 cwt 1 qr 0 lb
Total quantity of refuse burned per cell per 24 hours	9 tons 3 cwt 3 qr 1C lb
Total quantity of refuse burned per sq ft of grate per hour	28 C lb
Tons per man per shift	C tons 2 cwt 2 qr 9 lb
Total water evaporated	5C tons 1? cwt 0 qr 15 lb
per hour	2 tons ? cwt 1 qr 5 lb
per sq ft of heating surface per hour	3 04 lb
Total water evaporated per lb of refuse from and at 212° F or 100° C	1 2? lb
Mean steam pressure	16C 4 lb
feed temperature	?0° F
main flue temperature	2 190° F
temperature behind boilers	400° F

S W

WEYMOUTH MUNICIPAL CORPORATION—POPULATION, 19 831

A	1903 [1]
B	Meldrum s front hand fed
C	4 grates
D	2 Cornish 1 20 ft × 5 ft 6 in 1 20 ft × C ft 6 in

[1] Now in course of erection

E	60 feet
F	Steam jet blowers
G	Sewage pumping
H	16 tons

Fig 89 will serve to show the unique position of this destructor, which is being erected on the water side of the sewage works One of the large open collection tanks will be covered by the boilers and the air supply for combustion will be taken from the

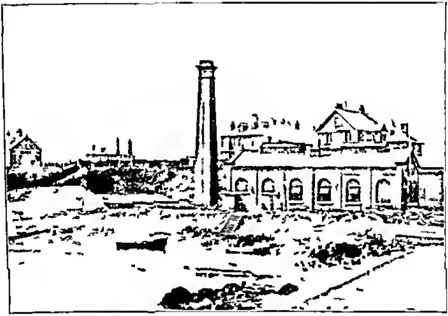

Fig 89 Weymouth Combined Destructor and Sewage Works External View

open tank through the covered tank and direct to the regenerator This constant exhaust will have the effect of removing all foul gases

The site is a very central one and its advantage in reducing the cartage cost will be clearly seen by referring to the following tabulated statement prepared by the Borough Surveyor, Mr W Barlow Morgan for presentation to the Local Government Board at the inquiry

Borough of Weymouth and Melcombe Regis Destructor

Estimated annual cost and repayment of loans—

	£	s	d
Brickwork in destructor	1,750	0	0
Buildings	1,290	0	0
Road	160	0	0
	3,200	0	0

	£	s	d
Loan for *20* years—			
Machinery and ironwork	1 400	0	0
	3 200	0	0
	4 600	0	0

	£	s	d
Annual cost—			
£4 600 at 3 per cent	138	0	0
Sinking fund 2½ per cent—			
£3 200 at 30 years	72	12	9
£1 400 at 20 years	54	14	9
	265	7	6

		£	s	d
Estimated annual saving to the rates—				
To present cost of coal used at pumping station		476	0	0
Estimated saving of 2 horses and 2 men per day Collecting refuse (7*s* 6*d* per diem)		234	0	0
		710	0	0
To the value of 1 250 tons of clinker at 2*s* 6*d*		156	5	0
		866	5	0
Deductions—				
To interest and sinking fund	£265 7 6			
Increase in working staff (2 *stokers at 24s each per week*)	124 16 0			
		390	3	6
		476	1	6

Nett assessable value £99 650

Rateable value 92 000

1*d* in the £ produces £356 £476 ÷ 1 33, say 1⅓ in the £

S W.

WIMBLEDON URBAN DISTRICT COUNCIL—POPULATION, 15,000

A	1900.
B	Meldrum's Beaman & Deas top fed
C	4
D	2 Babcock & Wilcox
E	150 feet.
F	Fan
G	Sewage Pumping
H	34 tons [1]
I	1s 8d
J	Average number of electrical units generated per ton of refuse destroyed 45

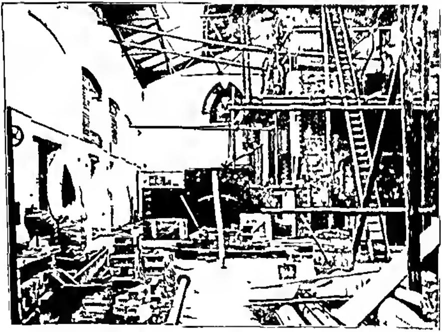

FIG 90 WIMBLEDON COMBINED DESTRUCTOR AND SEWAGE WORKS
View of Cells in Course of Erection.

Five supplementary coal fired boilers of the Babcock and Wilcox type are also installed, the power equipment of the station being as follows 5 Willans' engines, total H P 1800, 5 Crompton alternators, total capacity 1060 k w

[1] Two thirds of refuse and one-third of sludge.

Fig. 90 shows this installation in course of erection. It is probably the only combined works yet erected where sewage sludge is destroyed with refuse, and the power production, as will be observed, is eminently satisfactory. It is worthy of note that for the year ending March 31, 1902, a net profit of £1,358 was realized.[1]

WINCHESTER MUNICIPAL CORPORATION—POPULATION, 20,919

TWO INSTALLATIONS

	1	2
A	1884	1891
B	Fryer's top fed	Warner's top fed
C	1	2
D		•
E	80 feet	
F	Meldrum's steam jet blowers.[3]	
G	[2]	[3]
H	10 tons	
I	10d	

S W

WITHINGTON URBAN DISTRICT COUNCIL—POPULATION, 36,032

A	1902
B	Meldrum's front hand fed
C	4 grates
D	2 Lancashire
E	—
F	Steam jet blowers
G	Sewage pumping
H	36 tons
I	8d

This is an excellent example of a modern combined works. The sewage is lifted by 1 19", 1 15" and 2 10" Tangye centrifugal pumps. The two larger pumps are driven by compound engines of 68 and 35 H.P. respectively, while single 16 H.P. engines are provided for operating the two small pumps.

[1] Within the past year the Destructor has been combined with the Sewage Works on the same site.

[2] The gases are passed through a Green's economiser, and it is estimated that this effects a saving of £4 per week in the fuel bill at the sewage works.

[3] Added in 1897.

Twin air compressors of the [illegible] type are installed, also Johnson's sludge press plant having 42 chambers and capable of pressing 8 tons of sludge at each charge

L W

Wolverhampton Municipal Corporation
Population 94 187

A	1903[1]
B	Fryer's improved top fed [illegible], Beale's Wood & Fryer's patent
C	8
D	4 Babcock & Wilcox
E	—
F	Fan
G	Works purposes and electric lighting
H	—
I	—

S W

Worthing Municipal Corporation—Population 22 617

The Council have recently decided to erect a destructor of the Heenan type in combination with the sewage works The estimated cost of the destructor exclusive of excavation foundations buildings and chimney is £2 880 This is an interesting modern departure the sewage being lifted at present by means of gas engines and three throw pumps and while the latter will be retained they will be steam driven the steam being provided from the refuse

L W

Wrexham Municipal Corporation—Population 14 966

A	1900
B	Meldrum's front hand fed
C	4 grates
D	1 Lancashire 30 ft × 8 ft
E	120 feet
F	Steam jet blowers
G	Electric lighting and traction
H	3 tons
I	—
J	18

[1] Now in course of erection

Two supplementary coal fired boilers of the Babcock and Wilcox type are installed, and the power equipment of the station is as follows 3 Willans' engines, total H P 750, direct coupled to 3 Lancashire dynamos, total capacity 375 k w , also 270 Chloride cells of 300 ampere hours capacity

The log for two consecutive months' running is here given and is specially interesting, more particularly that of the second month January 1902, when no coal whatever was used even on Sundays

Date	Maximum Load in K w	Units Generated	Hours of Running Hrs Mins
Dec 1 1901	Sunday	Sunday	Sunday
2	118 8	557	6 25
3	114	658	6 30
4	123 5	712	6 25
5	121	646	6 40
6	80 8	557	6 25
7	133	803	7 25
8	Sunday	Sunday	Sunday
9	133	622	6 30
10	116 4	618	6 30
11	123 5	931	9 35
12	125 9	710	7 5
13	90 3	489	7 5
14	134 4	769	7 50
15	Sunday	Sunday	Sunday
16	117 6	737	7 30
17	118 8	600	6 40
18	123 5	936	14 35
19	135 4	966	10 30
20	86 7	400	6 40
21	148 8	756	7 30
22	85 5 (Sunday)	279	3 25
23	128 3	800	8 10
24	137 8	816	7 30
25	Christmas Day	—	—
26	No collection of refuse	—	—
27	No collection of refuse	—	—
28	131 4	748	8 0
29	80 8 (Sunday)	248	3 40
30	125 9	585	6 30
31	112 8	818	[illegible] 10

January 1902	Max Load in K.w.	Units Generated
Jan 1 1902	114	603
2	118 75	557
3	76	626
4	134 4	816
5	76	264
6	116 375	671
7	97 375	773
8	114	613
9	123 5	592
10	85 5	471
11	129 6	762
12	76	274
13	116 375	560
14	111 625	534
15	109 25	517
16	121 125	621
17	80 75	511
18	134 4	814
19	76	245
20	114	638
21	121 125	507
22	121 125	513
23	127 5	673
24	8[illegible]	309
25	134 4	810
26	83 125	256
27	121 5	576
28	125 875	542
29	121 125	447
30	118 75	481
31	85	349
Feb 1	140 125	708

Fig 91 illustrates a steam pressure curve over an ordinary day's run and fully bears out Mr Sillery's contention that "the steam pressure is constant and easily controlled."

It is worthy of note that this destructor was in constant use for the whole year ending June 5 1901 without being idle even for one day for cleaning or repairs and that for the first three years of operation which ended at the date already mentioned not one penny had been spent upon repairs

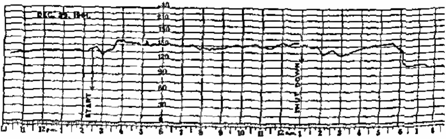

FIG 91 WREXHAM COMBINED DESTRUCTOR AND ELECTRICITY WORKS
Steam Pressure Diagram

With the improved load factor during the past few months, the fuel cost per unit sold has been reduced to 58*d*

YORK MUNICIPAL CORPORATION—POPULATION, 77,914

TWO INSTALLATIONS

	1	2
A	189	1898
B	Warner's top fed	Fryer's improved top fed
C	6	4
D	1 Multitubular	2 Babcock & Wilcox
E	—	—
F	Fan	Fan
G	Works purposes only	
H	—	—
I	—	—

Chapter XVIII

REFUSE DESTRUCTORS IN SCOTLAND AND IRELAND

Ayr Municipal Corporation—Population, 28,697.

E W.

A	1903 [1]
B	Meldrum's front hand fed.
C	6 grates
D	1 Babcock & Wilcox
E	120 feet, Custodi's type
F	Steam jet blowers
G	Electric lighting
H	30 tons
I	—

The electricity works have been in operation for several years past, and the following coal fired boilers are installed 4 of the Lancashire type, 2 Stirling water tube, and 1 Babcock and Wilcox

The power equipment of the station is as follows 8 Bellis, and 2 Marshall compound engines, 7 Siemens fly wheel alternators of 625 k w total output 2 Bruce Peebles' traction generators, 200 k w each, and 1 Siemens traction generator, 220 k w , a storage battery of E P S cells is also provided

Edinburgh Municipal Corporation—Population 316,793

A	1897
B	Horsfall's top fed
C	10 cells
D	1 Multitubular 14 ft × 7 ft
E	183 feet
F	Steam jet blowers
G	Forced draught
H	60 tons
I	2s 5½d

[1] Works now in course of erection.

GLASGOW MUNICIPAL CORPORATION—POPULATION, 781 000

[1] SIX INSTALLATIONS

	No 1 Cranford Street	No 2 St Rollox	No 3 Kelvinhaugh	No 4 Haghill	No 5 Dalmarnock	No 6 Ruchill
A	—	—	—	1898	1901 1903	1902
B	Own design	Own design	Own design	Horsfall's top fed	Meldrum's improved top fed	Fryer's improved top fed
C	11 cells	10 cells	9 cells	5 cells	10 grates	8 cells
D	—	—	—	1 Babcock & Wilcox	3 Lancashire	2 Lancashire 30 × 8
F	250 feet	250 feet	300 feet	250 feet	2 0 feet	200 feet
F	—	—	—	Steam jet blowers	Steam jet blowers	Fans
G	—	—	—	Forced draught & works purposes	Forced draught works lighting etc	Forced draught & works purposes
H	—	—	—	—	—	80 tons

[1] A further installation is contemplated

Some of the cells in Glasgow [illegible] years, the total weight of refuse [illegible] ably, as at some of the works [illegible] immense quantities being used for [illegible]

At the Dalmarnock works the [illegible] per ton at the works and is thus [illegible] It is stated that upwards of 20 tons of [illegible] week, and at the present time one firm [illegible] material, paying the sum of £1 360 per [illegible]

GOUROCK MUNICIPAL CORPORATION.—POPULATION, [illegible]

A	[illegible]
B	[illegible]
C	[illegible]
D	1 [illegible]
E	
F	Fan
G	[illegible]
H	[illegible]
I	[illegible]

GOVAN MUNICIPAL CORPORATION.—POPULATION, [illegible]

A	1892, 1894 and 1900
B	Warner's top fed
C	16
D	1 Multitubular
E	120 feet
F	Fan
G	Fan engine and works purposes
H	80 tons
I	18

PAISLEY MUNICIPAL CORPORATION.—POPULATION, 79 363

A	1900
B	Horsfall's top fed
C	8
D	1 Babcock & Wilcox
E	180 feet
F	Steam jet blowers
G	Clinker crusher, mortar mills and forced draught
H	42 tons
I	917

The total cost of this installation was £13,000; during the first eight months' working the sum of £236 5s. was realized from the sale of crushed clinker and mortar.

Partick Municipal Corporation—Population, 54,298.

A	1902
B	Fryer's improved top fed
C	6
D	3 Babcock & Wilcox
E	153 feet
F	Fans and steam jet blowers
G	Electric lighting
H	42 tons
I	1s. 7½d.

The three Babcock and Wilcox boilers set between the destructor cells are arranged for supplementary coal firing as may be necessary, while one additional boiler of the same type is also provided for firing with coal alone.

The generating plant installed is as follows: 2 150 k.w. sets, 2 75 k.w. Bellis-Bruce Peebles sets, and a Tudor storage battery of 184 cells.

The following figures for three months' working ending March 26, 1903, are of interest:—

	£	s.	d.		Per ton s.	Per ton d.
Tons of refuse delivered					3,874	
Expenditure—						
Wages	308	13	8	—	1	7¾
Interest and sinking fund	213	19	3	—	1	1¼
Stores	3	11	3	—	0	0¼
Total expenditure	£526	4	2	—	2	8¾
Revenue—						
Steam sold to Electricity Department, being 104,816 units at ⅜d. per unit	163	15	5	—	0	10
Clinker sold	7	13	2	—	0	0½
Balance, being cost to Burgh of destroying refuse	354	15	7	—	1	10
Total revenue	526	4	2	—	2	8¾

Average nearly 27 units generated per ton of refuse destroyed.

PORT GLASGOW MUNICIPAL CORPORATION—*Population* [illegible]

A	[illegible]
B	[illegible]
C	[illegible]
D	[illegible]
E	[illegible]
F	[illegible]
G	[illegible]
H	[illegible]
I	

BELFAST MUNICIPAL CORPORATION—*Population* [illegible]

A	[illegible]
B	[illegible]
C	[illegible]
D	[illegible]
E	[illegible]
F	[illegible]
G	[illegible]
H	[illegible]
I	[illegible]

DUBLIN MUNICIPAL CORPORATION—*Population* [illegible]

A	[illegible]
B	[illegible]
C	[illegible]
D	[illegible]
E	[illegible]
F	
G	[illegible]
H	[illegible]
I	[illegible]

The bulk of the refuse is taken out to sea and dumped. This system of disposal has long been recognized as unsatisfactory in the extreme, but owing to the enormous sums expended upon *electric lighting and traction there is a very evident reluctance* upon the part of the authorities to embark upon any scheme of sanitary improvement in so far as refuse disposal is concerned.

[1] Works now in course of erection.

E W

PEMBROKE URBAN DISTRICT COUNCIL (DUBLIN)—
POPULATION, 25,524

A	1900
B	Horsfall s back hand fed.
C	4
D	2 Babcock & Wilcox.
E	120 feet
F	Steam jet blowers
G	Electric lighting
H	12 tons
I	11¾d [1]

Three supplementary coal fired boilers are installed, these being of the Lancashire type each 30′ × 7′, also a Green's economiser

The power equipment of the station is as follows 2 250 H P three crank Easton, Anderson and Goolden engines, direct coupled to 4 75 k w Fynn dynamos, total capacity 300 k w , also 280 Chloride cells capacity 800 ampère hours

Details of an evaporative test in connection with the destructor are here given—

Date of test	June 1 and 2, 1900
Duration of test	24 hours = 1 day
Number and type of cells	Two cells single row Horsfall back hand fed
Total grate surface	60 square feet
System of forced draught	Horsfall Co s patent steam blowers
Nature of refuse	Unscreened house ashpit and garden
Number and type of boilers	1 water tube
Total quantity of refuse burned	18 tons 0 cwt 1 qr 21 lb
,, ,, per cell per 24 hours	9 tons 0 cwt 0 qr 24 lb
Total quantity of refuse burned per sq ft of grate per hour	28 lb
Cost of labour per ton burned	11¾d
Total water evaporated	18 tons 0 cwt 1 qr. 12 lb
,, ,, per hour	15 cwt 0 qr 2 lb
,, per sq ft of heating surface per hour	2 3 lb

[1] This figure applies to a test of 24 hours' duration

Total water evaporated per lb of refuse from and at 212° F or 100° C	1 21 lb
Percentage of clinker and ash to refuse burned	34 4 per cent
Mean steam pressure	120 lb
feed temperature	57° F
main flue temperature	1 800° F to 2 000° F
temperature behind boilers	600° F

Two tables of evaporative tests in connection with destructors are here given compiled by Mr Frank Broadbent M I E E of London and Mr J A Priestley A S I of Nelson respectively

In both cases the details given are sufficiently complete to make the figures of value for purposes of comparison In many instances it will be found that the complete figures of the tests have been previously given as also such particulars of the installations as the reader may find of interest in making more critical comparison

EFFICIENCY TESTS OF DESTRUCTORS

Compiled by Mr Frank Broadbent, M I E E

Locality and nature of refuse (1)	Duration of tests (2)	Type of boiler and grate area (3)	Weight of refuse per sq ft of grate per hour (average) (4)	Temperature in main flue or combustion chamber (5)	Temperature of waste gases (6)	Lbs of water per lb of refuse from and at 212 F (7)	Per cent of CO_2 in waste gases (average) (8)
Accrington ordinary town's refuse	22 hours	Lancashire 180 sq ft	29 7 lb	2 000° F	600° F	1 39 lb (F)	—
Ashton under Lyne ordinary town's refuse	24 hours (hot start)	Multitubular 180 sq ft	31 lb air pressure 1 25"	1 365° F (max) 1 241° F (av)	337 F	0 783 lb (E)	—
Bradford unscreened midden and market refuse	141 hours ordinary working conditions	Multitubular 180 sq ft	28 5 lb air pressure 0 6"	1 800 F	600° F	0 665 lb	—
Do do	278 hours	Do	34 lb	Do	Do	0 892 lb	—
Bury	4 hours	Lancashire	—	1 350° F	—	0 65 lb (E) (approx)	—
Canterbury town's refuse dry	8 3 hours	Water tube 50 sq ft	77 7 lb air pressure 3 625"	2 174° F maximum	550° F	1 51 lb (E)	—
Do do	200 hours ordinary working conditions	Do	57 5 lb	Do	Do	0 956 lb (E)	—
Colne ashpit refuse	9 5 hours	Water tube 50 sq ft	50 lb	Over 2 000° F (maximum)	—	1 15 lb (E)	—
Darwen unscreened ashpit and slaughterhouse refuse	49 hours	Lancashire 104 5 sq ft	24 5 lb	Over 2 000° F (max) 1 633 F (average)	585° F	1 55 lb (E)	—
Do do	8 hours	do	62 5 lb	2 000 F	—	1 71 lb (E)	14 13 %
Farnworth town's refuse (averaged) 24 per cent moisture	3½ hours	Lancashire 40 sq ft	42 lb	Over 2 000° F (maximum)	—	1 32 lb (E)	—
Do 26½ per cent moisture	5½ hours	Do	37 5 lb	Do	—	1 35 lb (E)	—
Do (dry) 10 per cent moisture	4½ hours	Do	29 5 lb	Do	—	1 76 lb (F)	—
Fleetwood unscreened ashpit refuse (very wet)	8 hours	Water tube 50 sq ft	80 5 lb air pressure 2¼"	Over 2 000° F (maximum)	350° F	1 191 lb (E)	—
Grays Thurrock unsorted ashbin refuse	7 hours starting warm	Lancashire 50 sq ft	76 25 lb	Over 2 000 F (maximum)	Feed water from economiser 299 F	1 22 lb (F)	—
Hereford unscreened ashpit refuse	10 hours	Galloway 90 sq ft	54 75 lb air pressure 1 8"	Over 2 000° F (maximum)	715° F	1 82 lb (F)	16 27 %
Huddersfield 1 part sewage sludge 2 parts town's refuse	24 hours	90 sq ft	49 lb	—	—	1 4 lb	—
Lancaster	12 hours	Lancashire 100 sq ft	62 lb	Over 2 000° F (maximum)	570° F	1 63 lb (E)	15 5 %

[illegible] house refuse [illegible] average [illegible] (per cell) [illegible]	42 hours	Water tube 100 sq ft	82.5 lb air pressure 2"	Over 2 000° F (maximum)	—	0 537 lb	—
[illegible] ordinary [illegible] refuse			71 7 lb	Do	—	0 86 lb (E)	—
[illegible] and [illegible] house refuse	Average working conditions [illegible] hours	Water tube 100 sq ft Lancashire 100 sq ft	64 5 lb air pressure 2[illegible]	2 093° F (max) 1 306° F (av)	770° F (max) 668° F (av)	2 35 (max) (E) 1 96 (av) (E)	19 8% (max) 14 4% (av)
Do	473½ hours work [illegible] continuously [illegible] work [illegible] 24	Do	[illegible] lb air pressure 1 5	2 612° F (maximum) 1 050° F (average)	530° F (maximum) 480° F (average) 555° F	1 96 lb (maximum) 1 85 lb (average) 1 06 lb (E)	15 6% (maximum) 13 16% (average) —
[illegible] unscreened [illegible] refuse		Lancashire 210 sq ft	[illegible] lb air pressure 1 125	—	—	1 97 lb	15 9%
[illegible] unscreened [illegible] refuse	[illegible] working [illegible]	Lancashire 80 sq ft	4" 3 lb	1 944° F (maximum) 1 200° F (minimum)	558° F	1 54 lb (E)	10 4%
[illegible] screened [illegible] refuse	[illegible] hours	Water tube 50 sq ft Lancashire	103 lb air pressure 3 1	Over 2 000° F (maximum)	—	2 24 lb	Refuse very imperfectly cremated
[illegible] unscreened refuse [illegible] ordinary boiler [illegible]	11 hours		[illegible] lb air pressure 1 12	1 760° F	1 380° F	1 18 lb	—
[illegible]	19 hours	Water tube 68 sq ft	30 2 lb	—		0 96 lb	—
[illegible] refuse	[illegible] hours 12 hrs (first start)	Water tube Multitubular	60 lb			0 71 lb	—
[illegible] unscreened [illegible]	11 hours		—			0 33 lb	—
[illegible] very light refuse		Do	—			1 3 lb (E)	—
[illegible] screened [illegible] refuse	[illegible] hours	Water tube 101 sq ft	44 6 lb air pressure 2	Over 2 000° F (maximum)	650° F	1 31 lb (E)	
Do [illegible] refuse and [illegible] sludge	5 [illegible] hours	Do	[illegible] lb			1 23 lb	
[illegible]	24 hours	Water tube 18[illegible] sq ft	24 6 lb	[illegible]	4[illegible]0° F	1 [illegible] lb	
[illegible] screened [illegible] refuse [illegible] 2 parts [illegible]	[illegible] hours	Water tube 50 sq ft	[illegible] air pressure 2 3	—		0 [illegible] lb	
[illegible] refuse at [illegible] sewage sludge [illegible]	[illegible] hours	Do	[illegible] lb air pressure 2 [illegible]			[illegible] lb	
[illegible] boiler [illegible] slack [illegible] (about 12 [illegible])	[illegible] hours	Lancashire 45 sq ft					

(E) means that an economiser was used.

[illegible]

[illegible]

Chapter XIX

REFUSE DESTRUCTORS ABROAD

AMERICA.

AFTER perusing the recently expressed opinions of some American experts in the opening chapters, the reader will not expect to find any remarkable record of American practice in these pages.

Many American destructors or crematories might be described as also some few systems of reduction, but no good purpose would be served by so doing. So many destructors or crematories have failed in America while so many now in use are admittedly unsatisfactory that on the whole a description of past and present systems would possess but little if any educational value. The opinions of American experts already quoted very clearly explain the causes of failure in many cases, and of only partial success in others.

Concerning systems of reduction it may be fairly submitted that their record is on the whole quite as unsatisfactory as that of crematories. Although reduction still has many advocates there is every reason to think that it will become increasingly unpopular and at no distant date it is likely to be entirely abandoned. Reduction as a system possesses several highly unsatisfactory features. *Firstly* only a small proportion of the total waste is dealt with. *Secondly* it is a process inseparable from nuisance and nuisance of such a character as has never been known in connection with even our earliest destructors. *Thirdly*, it involves the erection of a very costly plant. *Fourthly* the cost of operation is very high. And *Lastly* it should not be forgotten that the erection and operation of such plants have always been

undertaken purely and simply as commercial ventures and not as sanitary necessities

To no slight extent has the last named factor also exercised a pernicious effect upon systems of destruction by fire The commercial element has always been too prominent In this country, we frequently hear of the commercial element also, but only in so far as a municipality is anxious if possible to make a sanitary system pay its way

There is clearly no comparison between this very laudable desire and that of the American contractor who contracts with a municipality to dispose of its refuse for a number of years on such terms as will at any rate ensure a profitable transaction for himself. The whole business partakes of a commercial and speculative nature which is unsatisfactory in the extreme

Whatever may be said for or against company and municipality in questions of lighting or traction, it is clearly the duty of municipalities to deal with sanitary problems themselves The contract system is unsatisfactory, and open to very serious abuse It is safe to say that if sanitary problems were faced as they have been in this country, American practice would not only be interesting, but highly instructive

Having dealt with the general design and construction of most of the American crematories[1] in a previous work, and as many of the various types therein described are no longer used, it would serve no useful purpose to again describe a number of crematories which are for the most part weak in design, and which have a very unsuccessful record

To the British engineer it will doubtless be a source of satisfaction to know that in this particular branch of engineering we have nothing to learn from American design or practice

Likewise the British sanitarian must observe with pleasure the premier position of his own country, viewing with amazement the utter disregard of elementary principles of sanitary science shown by our kinsmen across the Atlantic

[1] See "*Refuse Disposal in America*, chapter xviii *The Economic Disposal of Towns' Refuse*. By W. Francis Goodrich.

It is most difficult even if not impossible to compile anything like an accurate record concerning refuse disposal in American cities Seeing that for the most part both crematories and reduction works are operated by companies under contract and not by municipalities, reliable data cannot be obtained

The following report prepared by an expert, while being comprehensive and interesting, only serves to emphasize the very unsatisfactory condition of refuse disposal in America The weight of opinion among experts is all against reduction systems, there are points in the reports of Mr James G Bayles here quoted *in extenso* which are distinctly in agreement with the opinions of other American experts previously quoted In every case we have a frank admission of weakness—a clear indication that the whole question of refuse disposal has still to be faced

BOARD OF ESTIMATE AND APPORTIONMENT CITY OF NEW YORK

BOARD MEETING AT THE MAYOR'S OFFICE, CITY HALL, TUESDAY, OCTOBER 1 1901

STATEMENT[1] PRESENTED BY THE HON BIRD S COLER Comptroller

The Comptroller presented the following:—

JAMES BAYLES M E Ph D Consulting Engineer for Public Utilities, Gas and Water Undertakings Sanitation etc

NEW YORK OFFICE No 338 PARK ROW BUILDINGS
October 1 1901

HON BIRD S COLER Comptroller HON RANDOLPH GUGGENHEIMER, President of the Council

"SIR —I hand you herewith a report which seems to conclude the first part of my work as expert for the city in the matter of the investigation and valuation for purposes of purchase of a plant of the New York Sanitary Utilization Company

"The conditions were such as to impose upon me the conscientious obligation of advising that no steps be taken looking to the expression of 'intention' on the part of the city to buy the plant

"In the work done thus far I have not had opportunity to give the city the benefit of the investigation of other methods of garbage disposal which I deemed consistent with the duties I was entrusted by you to perform The subject is a large one and information concerning it, as exact as can be compiled from the mass of more or less trustworthy

[1] Which was entered in full

official and unofficial data, should be at the command of the Boai Estimate and Apportionment In outline, I may say that my s of the subject satisfies me that the garbage should be disposed o gathered, without accumulation on scows and flotation, to a re point where a great public nuisance may be maintained

I believe that the cost of disposing of the city's organic refuse be materially reduced, and that very much better results than are reached are possible, *if the idea of utilization is abandoned, and the destruction by approved modern appliances is substituted* I see no re why this cannot be done at the dumps where the material is now lected and without creating any greater nuisance than is insepar from its receipts in carts I believe the whole system now emple is crude unscientific and expensive, and that New York is in a posi to dispose of its organic refuse more expeditiously, cheaply and s factorily than is done in any American city The inquiry is a ser one and without special authorization I do not deem it my duty to e upon it

I await your further instructions

Respectfully,
JAMES BAYLES

NEW YORK *September* 30 1901

HON BIRD S COLER Comptroller HON RANDOLPH GUGGENHEIM President of the Council

SIR —As the result of my study and investigation of the quest of the disposal of the garbage of New York and Brooklyn, and of advantages or disadvantages to accrue to the city from the purch of the Barren Island plant of the Sanitary Utilization Company, un the clause of the contract of 1896 which has been assumed to give city the option of purchase, I advise that no steps be taken in the mat of giving the notice of intention on behalf of the city, for which s clause provides

A consensus of legal opinion would probably show that what l been assumed to be an option conferred upon the city by the contr of 1896 is valueless *It would appear to have been so drawn as to adı* of almost any interpretation which may be put upon it As it was d cussed at some length in my report of September 12, I probably do 1 need to go over the subject again, further than to say that subsequ conversation with the council of the Sanitary Utilization Company co vinces me that if any one having authority to do so should give tl required thirty days notice of 'intention, it would be interpreted committing the city to the purchase of the plant, and might very w give rise to a costly litigation to compel its acceptance, whatever t showing of the Company s books as to the results of five years of operati under the best management obtainable

In the report referred to I recommend that if the required noti could be given on behalf of the city without constituting an express

or implied obligation to take the Barren Land plant, that course be taken, to the end that the Board of Estimate and Apportionment might be put in possession, by expert investigation, of the facts necessary to a decision, whether it is to the city's interest to own it or not.

"I am now convinced that this course is impracticable. The council for the Sanitary Utilization Company are disposed to avail themselves of every technical advantage of interpretation, and the directors are obviously unwilling to have any investigation made pending a decision on behalf of the city to purchase. I attribute this to the fact that the result of such investigation would convince any impartial person qualified to form a judgment that the business is one without attractions for private capital, and with fewer still for a municipality. Not having received any confidential information from the Sanitary Utilization Company, but a great deal from well informed sources which imposed no obligations of confidence, I have no hesitation in saying that I believe the business has thus far been unprofitable to the Company. It has employed a large capital, it now calls for important and costly extension, and has made no return to the stockholders. I have no doubt the Company would be glad to sell the plant and business, but the hopelessness of finding

in garbage utilization. Its two products are grease and tankage. After the most careful investigation which I have had opportunity to make, I could not conscientiously advise the municipal authorities to undertake their manufacture even if the Barren Island plant were given to the city.

"At this date prime city tallow—the best grade of grease material—is worth 6 cents a pound. This is very high, its normal price being about 4½ cents. Garbage grease is black and in appearance more resembling asphalt varnish of low grade than any other material with which I can compare it. If a parity could be established between it and tallow, it would now be worth about 3½ cents, but as a matter of fact, it is almost unsaleable. For this there are two reasons: it is an undesirable material, and the increased production and lower price of palm oil is displacing it from admixture with other material in uses which might be found for it if palm oil were scarce and dear. It is accumulating in store at the present, and if forced on the market it must be sacrificed. With tallow high in price and relatively scarce from the partial failure of the corn crop the demand for it should be at a maximum, whereas it is at minimum. If the price of tallow holds garbage grease should be nominally worth 2½ to 3¼ cents, and only moderate quantities could be sold in this country even at that price.

"The export demand for this material is not steady or dependable. I have been in conference with a dealer, an expert in grease, who has been several times to Europe to make a market for American garbage grease, and has always succeeded in doing so. He tells me, however, that owing to its low grade and dark colour, which excludes it from use in soap making even in the cheapest grades of laundry soap, he has been

unable to hold the business thus secured, and does not consider that the material can ever compete successfully as a commercial product with grease from other sources. Should the city become a producer of garbage grease, it would, no doubt, be possible for it to contract for its sale at a low price with a dealer willing to buy it speculatively, and carry it in stock where there was no market for it. The city could probably not produce it for two or three times its maximum market value, nor handle it commercially without heavy annual loss. The fire risk of a large quantity of this material is also very great.

From the fertilizer dealers I learn that, while the dried material remaining after the grease and water has been expressed has a limited use as a dilutent of cheap fertilizers, it is the lowest grade material of its class. Its nominal value in bags at works is about 5 dollars a ton but the demand for it fluctuates and it will not bear transportation for any distance. Just now it is in very light demand and a considerable quantity could be purchased at a price somewhat below its nominal market quotation. The reason the tankage of the Boston utilization plant is not saleable is probably that it will not bear transportation to a market where it is wanted. In the shape in which it is produced the farmer cannot use it profitably, even if it cost him nothing but cartage.

There is also a technical side to the business of garbage utilization which is known only to a few, and to command the experience which has been gained experimentally at so great a loss would undoubtedly cost the city a large sum in annual salaries.

Garbage carries from 2 to 3 per cent of grease, accordingly to the season. Naturally it is lower in summer than in winter. To get it out by the process employed by the Sanitary Utilization Company is apparently a very simple matter, but it is really very difficult. If the 'cooking' is not just right, its separation is impossible. If the steam pressure is higher than it should be the whole mass is reduced to pulp, in which condition it all passes through the straining cloths in the presses, and no subsequent separation is practicable. There are also conditions in which the grease forms an emulsion with the water, and will separate at any temperature. The care and management of a plant are also matters requiring the skill gained from experience and even then its deterioration is rapid. The digesters are attacked by the acids and salts in the material treated, and are at best, short lived. It is impossible to tell what is going into them at any given time. Even the most complete qualitative analysis would fail to indicate what combinations are or may be formed during the cooking process. Disastrous explosions in different parts of the plant have occurred under conditions which rendered satisfactory explanations impossible. I have examined discarded tanks, which were honeycombed by energetic corrosion and from their appearance outside and inside I should consider working in a plant of this character an extra hazardous occupation.

The record of utilization plants in this country and Europe concerning which I have been at much pains to advise myself, has been generally successful. That a majority of the plants built for grease

Milwaukee.—Plant destroyed by fire, and not rebuilt.

Detroit.—Plant crippled by fire and rebuilt, but is understood not to have paid. The original capital of the company was wiped out. The inducement to rebuild is understood to have been an advantageous contract for the sweeping of the streets.

St. Louis.—Plant destroyed by fire, but rebuilt and now running in a small way. Holders of stock in the St. Louis Company tell me they have never received any returns on their investments.

New Bedford.—Plant burned out twice, but rebuilt, and now running in a small way.

Reading.—Undertaking not a success. I am informed that the capital of the company was wiped out in the losses of operation, and that it is now engaged in litigation with the city involving $100,000.

Pittsburg.—Plant now in operation. The original company failed, but the business was taken up by a concern which is engaged in the fertilizer industry. As to its financial history, since passing into the present ownership I have no information.

Syracuse.—Plant in operation, but it is understood that the company has made no money.

Paterson.—Plant was built by a strong company, with a liberal and broad-minded management. It was burned down, and was not rebuilt.

New Orleans.—Plant still standing, I believe, but the company which built it went into liquidation, having sunk its capital. Cincinnati, Indianapolis, Philadelphia and Boston have operative garbage utilization plants. The same is true of Washington, where the original investment, $200,000, was wiped out by the burning of the plant. New works were built and are understood to be as satisfactory as any in the country.

This is probably not a complete list of American plants of this general character, but it includes those of greatest prominence. In briefly outlining their history I have summarized the best data obtainable and believe that my information is correct. It is known to every one for whom this subject has interest that millions of dollars have been lost in efforts to make a commercial business of garbage utilization. It seems to have unusual attractions for investors, who are allured by the promise of the recovery of large profits from a waste material costing nothing and in unfailing supply. In no instance have I found a situation warranting the belief that, as a business venture, the building of a utilization plant as a business undertaking has not illustrated what the late Senator Conkling described as "the bright beginning and the bitter end of a halcyon and vociferous proceeding." I am not prepared to say that the progress of the arts will not ultimately give us a method of extracting grease from garbage profitably, but of this, as of the gold in sea water, it may be truthfully said that it now costs more to get it than it is worth when recovered. The chemical industries furnish many like problems and much value is wasted because it does not pay to save it.

In my report of September 12 I described in sufficient detail the plant of the Sanitary Utilization Company on Barren Island. Should the city desire to engage in the business, I am not sure that it could begin to best advantage by buying that plant. It is experimental from the first, and has admittedly cost a great deal more than any conscientious appraiser could accept as its present valuation. The company has had to feel its way through a great many difficult problems; others confront it which are not yet solved, and notwithstanding the liberal compensation received from the city, the stockholders claim to have had no return in dividends. Further considerable investments in machinery are immediately necessary and the replacement account must be burdensome. I think it doubtful if, for another year or two at least, its garbage contract will be satisfactorily profitable. I am assured that its operations under the five-year contract of 1896 were not.

The principal argument advanced by the advocates of garbage utilization is based on the "sanitary advantages" of this method of disposing of the organic waste of a city. Whether these advantages are more or less depends upon the method chosen as offering a standard of comparison. Utilization is unquestionably better than "tipping" or dumping at sea, or allowing putrescible refuse to accumulate in cities

Although patentees of American cremators are frequently loth to make the admission, it is nevertheless true that every attempt yet made to destroy garbage by fire has necessitated the use of a considerable weight of added fuel, and the cremator or secondary fire is an integral part of every cremator yet devised for dealing with garbage.

Fig. 92 is a longitudinal section of the "Dixon" cremator, a representative American type. It will be observed that not only are two coal fires provided, one at the end of the main destroying chamber and the other immediately underneath at the end of *the evaporating chamber*, but in addition a third fire, coke fed, is arranged at the chimney base.

Now those who are intimate with the composition of refuse in the South of England in midsummer are well aware that such refuse is in the main garbage pure and simple, yet in spite of this no secondary fire or fuel is used and in summer, as in winter, power

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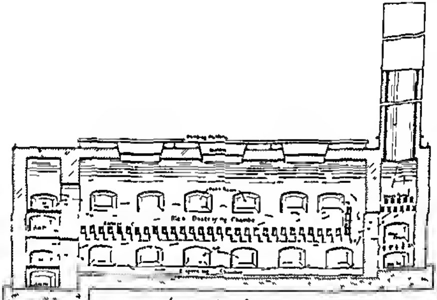
is supplied for the various municipal purposes herein discussed This cannot be disputed Day by day the work goes on, and there are several examples, notably sewage works, where no other fuel but refuse has been used since the destructor was erected

Notwithstanding the use of coal, coke, or other fuel in connection with American crematories, complaints concerning nuisance are frequent *It is true that within the past two or three years complaints have been less frequent,* but possibly



Longitudinal Section
Fig 92 The Dixon Crematory

this may be attributed either to the use of a larger proportion of added fuel, or increased vigilance Certainly there has been no drastic improvement in design, or indeed any improvement which would tend toward the avoidance of nuisance, unless a good proportion of added or secondary fuel be used.

Owing to serious complaints of nuisance at Trenton, N.J., where a crematory of the "Davis" type is installed, a consulting engineer was engaged to investigate and report to the city authorities—*firstly,* as to the nature and extent of the trouble,

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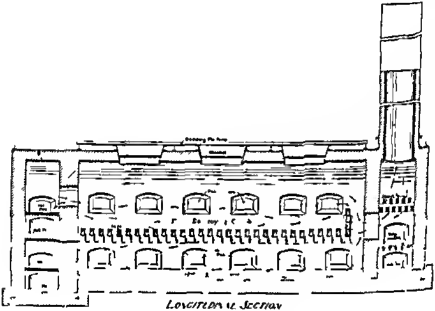

FIG 92 THE DIXON CREMATORY

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Owing to serious complaints of nuisance at Trenton N J where a crematory of the "Davis" type is installed a consulting engineer was engaged to investigate and report to the city authorities—*firstly*, as to the nature and extent of the trouble,

and *secondly* to make such recommendations as might be needed to improve the installation

Complaints have been made concerning the escape of dust from the chimney and it was also alleged that escaping sparks had been responsible for fires in the immediate neighbourhood of the works As the result of investigation it was clearly proved that sparks were discharged from the chimney and that they occasionally travelled a distance of 150 to 200 feet from the chimney

The installation at Trenton comprises two "Davis" crematories each consisting of a combustion chamber, a drying chamber (having an evaporating pan beneath) and also secondary fire grates The works are situated in a thickly populated neighbourhood The chimney is 120 feet in height, and is approached by a somewhat contracted main flue in which is arranged a set of screens to intercept dust particles

Presumably the Trenton plant may be considered as a modern example if this be so then it must be admitted that much remains to be done When it becomes necessary to intercept dust by means of screens a serious weakness in the design is at once manifest

As the result of the investigation recommendations were made which if adopted would certainly tend to ensure satisfactory working thereafter and it is interesting to observe that the various recommendations made are such as would be made by a competent engineer having *experience of destructor work*, thus at once emphasizing the *soundness of the views expressed* by such authorities as Mr *Rudolph Hering and Colonel Morse*

Some details of a test *carried out* with the *Trenton* installation are here given —

RESULTS OF OPERATION OF THE GARBAGE CREMATORY AT [illegible] N.J. FOR ONE WEEK [illegible]

Total garbage burned	[illegible]
Garbage burned per day	[illegible]
Coal used [illegible]	[illegible]
Coal used [illegible]	[illegible]
Total coal used	[illegible]

[illegible] No 1 January [illegible]

Coal used per day	2 3 tons
Garbage burned per ton of coal	13 8
Approximate average time of operation per day	14 hours
Equivalent number of days of 24 hours	3 5 days
Equivalent garbage burned per sq ft grate area per day of 24 hours	1 080 lb
Equivalent amount of garbage burned per cell of 25 sq ft per day of 24 hours	13 5 tons
Estimated total weight of clinker from garbage and coal grates	14
Estimated weight of ashes from ashpits	3
Percentage of ashes and clinker to garbage burned	9 1 per cent
Range of temperature of gases in chimney	600–1 000° F
Percentage of moisture in garbage	81 per cent
Corresponding water evaporated daily in furnaces	25 5 tons
Quantity of coal required per day to evaporate this water on a basis of 10 lb of water per lb of coal	2 5

Reduction v Destruction

As already observed, the former system only provides for the disposal of a comparatively small portion of a city s waste To render such a system of disposal workable it devolves upon the householder to keep the various classes of waste distinct and in the collection of the waste separate collections are demanded because the bulk of the total waste has to be disposed of otherwise by the authorities Fig 93 illustrates the sorting of refuse at Boston where a crematory of the Morse Boulger type has also been erected

The general average composition of the refuse of an American city would seem to conclusively show that sufficient material of good calorific value is collected to readily destroy the objectionable portion of the refuse always providing of course that the *whole* be burned in an efficient destructor

The refuse of an average American city is of the following composition—

	By weight	By volume
Garbage	13 per cent	18 per cent
Ashes	80	77
Rubbish	7	2
	100	100

Ordinary kitchen garbage consists approximately of—

	By weight
Animal and vegetable matter	20 per cent
Grease	3 ,, ,,
Water	70 ,, ,,
Rubbish cans rags etc	7 ,, ,,
	100 ,, ,,

It has been estimated that in a city such as New York, no less than 20 per cent of recoverable coal is contained in the

FIG 93 BOSTON REFUSE DISPOSAL WORKS SORTING ROOM

ashes collected from private houses and apartment houses This being so, then it is a very strong argument in favour of the erection of destructors, such material would be found of immense value not only for effectually cremating the organic and objectionable waste, but in providing an immense amount of power for various municipal purposes

According to the late Colonel G E Waring, jun,[1] "city garbage from kitchens and markets consists of about 7 per cent of

[1] See *Report on the Final Disposition of the Wastes of New York* By George E. Waring, jun, Commissioner, 1896

rubbish—cans, bottles, rags, etc , 70 per cent water, 3 per cent grease, and 20 per cent of a mixture of animal and vegetable matter of a dry character

"To cook the raw garbage and separate it into the four substances (i e) rubbish, water, grease, and fertilizer material, is the object of all garbage reduction or utilization systems

"The rubbish has scarcely enough value to repay its separation and the water has none at all To get rid of these two substances averaging 77 per cent of the whole, is the expensive part of any reduction process"

It is beyond dispute that the cost per ton dealt with by a reduction system is very high, so high indeed that taking every factor into account it may be submitted that it would be possible for an average community to dispose of the *whole* of its waste for very little extra per ton than has been cheerfully paid for the disposal of a portion only

In order to arrive at a basis for fair comparison, one must take into account the whole of the capital and standing charges for a reduction plant, not forgetting the depreciation, which must ever be a very serious item, because we are comparing the cost with that of a system which deals with the *whole* of the waste

The assets must of course be allowed for, but it may be observed in this connection that such assets have up to the present not shown themselves to be of equal value to the assets from a modern destructor plant

The costs in connection with a reduction plant usually cover the collection and transportation of the garbage, and it is but fair to point out that a modern destructor can be erected on a central site, such a site as ensures the minimum cost for collection, while on the other hand the reduction works cannot under any circumstances be erected within a city, and for purposes of argument we may therefore assume that the collection costs would be doubled

Further, all available figures clearly show that even a first-class modern destructor, complete with steam boilers, can be erected for less money than a reduction works for a city of similar size, while in the case of the former the *whole* of the

system. Separate collection of the waste and sorting would cease entirely, and destruction by fire would speedily become as popular as is the case in this country.

As already indicated, the commercial aspect has counted for much in the development of reduction, and it may be fairly assumed that the commercial aspect of destruction, once demonstrated, would appeal strongly to a people possessing no mean utilitarian record.

To the British student of the subject it must be obvious that the power aspect of refuse disposal alone is likely to induce a commercial people to abandon that *laisser faire* attitude concerning their filth, which is the most serious stumbling block to sanitary progress.

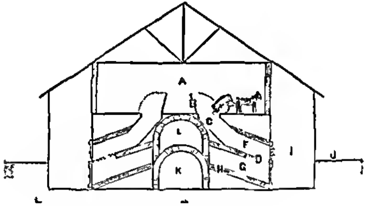


FIG. 94.—MONTREAL DESTRUCTOR, THACKERAY TYPE.

CANADA

MONTREAL—POPULATION 267,516.

The refuse of the Western district of this important Canadian city is destroyed in a destructor or incinerator of the Thackeray type. Fig. 94 is a cross section of the Thackeray destructor as erected in Montreal. It will be observed that in design it is very similar to the original Fryer destructor. Twelve cells are provided, arranged back to back, each cell having a grate area of 72 square feet.

The chimney is 175 feet in height, and a fume cremator has

been erected at the chimney base. Natural draught only is now used. Fan and steam jet blower draught have both been tried and abandoned. A steam boiler which was originally set at the chimney end of the main flue has been removed.

The destructor was erected in 1894 at a cost of $41,000 and has been in constant operation ever since. During the year 1901 13,659 tons of refuse was destroyed at a cost of $12,778, equal to about 93½ cents per ton of refuse destroyed.

ANALYSIS OF HOUSEHOLD REFUSE OF MONTREAL.[1]

	Summer	Winter
Kitchen waste	65 per cent	25 per cent
Paper	15 "	10 " "
Tin cans, bottles, old boots, rags, etc.	10	5 " "
Ashes	10	60 " "

The high percentage of ashes in winter is of course due to the low temperature, the lowest temperature in the winter being given as 25° F., and the highest summer temperature 93° F. in the shade.

The author is indebted to Dr. Elzear Pelletier, of Montreal, for the foregoing information concerning the disposal of the refuse of that city.

SOUTH AMERICA.

Bahia.

About a year since this municipality decided to erect three destructors to the design of Mr. Price Abell, a British engineer.

Buenos Ayres (Argentine).

A small experimentary destructor was erected by Messrs. Baker about two years since.

Georgetown (British Guiana).

A small destructor of the Fryer type was erected here several years since.

[1] Analysis made by Mr. J. E. Doré, Municipal Sanitary Engineer.

MANAOS (State of Amazonas)

A three-cell Colwell destructor was erected here by Messrs Baker in 1901, two Hornsby water tube boilers were provided, these being set between the cells

PARA (Brazil)

Some twelve years ago a small destructor of the Fryer type was erected here, followed a few years later by a Horsfall destructor of the top fed type

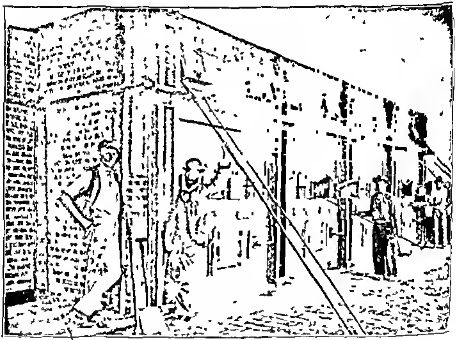


FIG 95 PERNAMBUCO DESTRUCTOR VIEW OF CELLS

PERNAMBUCO (Brazil)

A four-cell Horsfall destructor of the back fed type was erected here in 1896 One multitubular boiler, 10 ft. by 6 ft., is provided, and this supplies steam for the steam jet blowers and also for driving a mortar mill The chimney is 60 feet in height, and about 26 tons of refuse is destroyed per 24 hours Fig. 95 is a front view of the cells.

Peru.

While a few cities on the eastern seaboard of South America have adopted modern destructors, the time-honoured system of tipping, perhaps in its most objectionable form, is still practised in many large cities on the west coast. According to a recent report from the capital city of Peru, one refuse tip known as "Tajamar" is still being added to day by day, although it has been in existence ever since Lima was founded.

As the city was founded in 1535, the "Tajamar" tip will probably rank as the oldest deposit of its kind, and it furnishes striking evidence of that apathy and disregard of sanitation which is a feature of most countries administered by Spaniards or those of Spanish descent.

One of two brief extracts from the report already alluded to will doubtless be of interest—

Parte II.—*Destruccion de la Basura*.—Referring to the "Tajamar" tip, the writer remarks: "It is situated in the river bed, and now reaches a height in places of from 15 to 20 metres . . ."

Referring to another tip, known as the "Martinette," we are told—"I noticed several persons at this tip who were sorting the refuse, and I believe that people sleep there at night. The great objection to this practice is that these people mix with the rest of the inhabitants in the streets, and are liable to transmit any disease that they may have contracted at these dust heaps. . . . I consider that all refuse heaps should be surrounded by a fence, so as to prevent access to them by the public . . . Alongside of the Hospital de Mayo there is a piece of waste ground on which loads of street sweepings and other refuse is deposited, also several dead animals; this is a most objectionable practice in such close proximity to an hospital."

Such is the report of a British engineer concerning the refuse disposal of a city now having a population of over 200,000, and one of the finest South American cities.

CONTINENTAL PRACTICE.

Continental practice is, perhaps, of greater interest to the student, emphasizing as it does the excellence of the British destructor, and clearly showing that our British practice can only be emulated by the adoption of British destructors.

Destructors of Continental design have been but few in number and their record is not a satisfactory one As in America so on the Continent the problem has never been approached as a problem and consequently it remains a problem Such British installations as have been erected and which are here briefly recorded have on the whole been very satisfactory

The wretched practice of tipping refuse so common in this country is in vogue all over Europe That it is not so severely condemned in many Continental countries by the medical profession as is the case here is quite true but such indifference is no argument in favour of a filthy system Such laxity but serves to show how assiduously our medical officers of health attend to their primary duty—the preservation of the health of a community

Sorting and utilization is extensively practised in Continental cities According to some reports it possesses economic advantages under the peculiar existing conditions but by no stretch of the imagination can such a system be called sanitary In this country some of the strongest opponents of all systems of sorting and utilization are found among our medical officers of health and such systems which have never been popular here are now almost entirely discarded and it is quite certain that a revival is impossible

When our Continental neighbours inspect destructors in this country as frequently happens their investigations are of the most searching and thorough character The author has been impressed many times by the determination of the foreign visitor to see all that is to be seen and to so see that he understands clearly

Close investigation in a destructor building often involve much personal discomfort but our foreign visitor is not daunted he appears quite willing if necessary to ruin a suit of clothes rather than gather a mere hazy notion concerning something which may not be quite clear to him

The copious notes taken the intense interest shown and the discomfort endured all stand out in sharp contrast when compared with the visit of the average British councillor, who too

often likes to stand at a very considerable distance from that which he has come to see Our British visitor coughs when there is no occasion to do so, and sometimes pinches his nose when looking into a cell at almost white heat He does not like to come too near, it is unpleasant, whereas if it were possible to get closer to any object of interest by proceeding on all fours our foreign visitor would not hesitate to do so

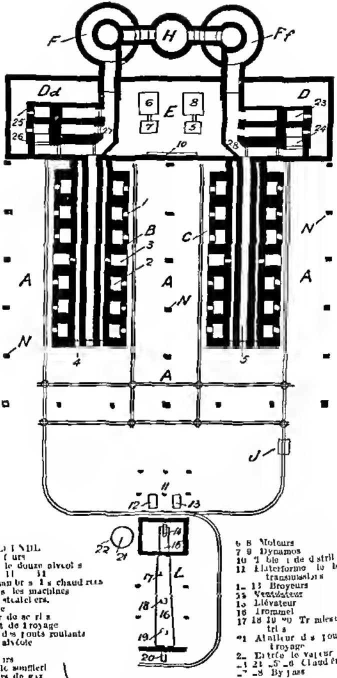
However well a destructor works may be designed and managed, close investigation of actual working conditions is impossible without some little personal discomfort to the lay visitor It may perhaps be granted that the atmosphere does not inspire searching investigation, but the fact nevertheless remains that deputations are sent to *investigate*, and it gives the author no pleasure to remark that the example set by many Continental deputations might worthily be followed by British deputations

It will be observed that although comparatively little has been done on the Continent in the way of final and sanitary disposal, yet some notable cities have shown the way, and while progress is slow there is every indication that disposal by fire will ere long be recognized as the only solution

Brussels (Belgium)

A destructor of the Horsfall type, comprising twenty four cells, top fed and arranged back to back, has recently been erected at the "Quai de la Voirie" Four water tube boilers are provided, and also two centrifugal dust catchers Electrically driven fans supply forced draught to the cells The chimney is 45 metres high, having an internal diameter of 250 centimetres The destructor has a capacity of 150,000 kilos per twenty-four hours, and the power is used for works purposes, including the fans already mentioned, electrical cranes for lifting the refuse on to the top of the cells, also for the electric lighting of the works, and the operation of a clinker utilization plant, including screens and crushers

Fig 96 is a block plan which shows the general arrangement of the plant at Brussels



LÉGENDE

A Hall des fours
B Batterie de douze alvéoles
C " " "
D et D1 Chambres des chaudières
E Chambres des machines
F et F1 Dépoussiéreurs
H Cheminée
J Mouilleur de scories
L Bâtiment de broyage
N Cylindres des ponts roulants
1 Portes d'alvéole
2 Alvéoles
3 Ventilateurs
4 Canaux de soufflerie
5 Collecteurs de gaz

6 8 Moteurs
7 9 Dynamos
10 Tableau de distribution
11 Plateforme de broyage et transmissions
12 13 Broyeurs
14 Ventilateur
15 Élévateur
16 Trommel
17 18 19 20 Trémies des produits triés
21 Abatteur des poussières du broyage
22 Entrée de vapeur
23 24 25 26 Chaudières
27 28 By-pass

FIG. 96. BRUSSELS DESTRUCTOR
Plan

FREDERIKSBURG MUNICIPALITY (Copenhagen) Denmark

A large destructor of the Sterling type has recently been completed boilers of the Babcock & Wilcox type being provided in connection therewith The available steam power will be used for heating and lighting purposes at a large hospital in close proximity to the destructor works

GIBRALTAR

A two-cell Fryer destructor was erected here about ten years since The height of the chimney is 90 feet About fifteen tons of refuse is destroyed daily

BERLIN (Germany)

A number of experiments have been made in this city In 1895 a three cell Horsfall destructor was erected followed by a two-cell Warner destructor but after exhaustive experiments it was decided not to instal further cells of either make

Owing to the unusual composition of Berlin refuse and the freedom from combustible material considerable difficulty was experienced in securing a vigorous combustion both with steam jet blower draught and fan draught Latterly experiments have been made with a furnace of German design and in so far as temperature and efficient combustion is concerned very satisfactory results were obtained it is however but fair to add that a considerable quantity of coal dust has been used to assist combustion

HAMBURG (Germany)

A thirty six cell Horsfall destructor was erected in 1895 The cells are of the top fed type and arranged back to back Four multitubular boilers are set in connection with the cells, supplying power for the electric lighting of the works also for operating electric cranes fans for forced draught clinker crushing and screening plant as well as for pumping purposes The chimney is 48 6 metres in height, and 2 4 metres internal

diameter During the year 1900 an average of 270 288 kilos of refuse was destroyed per twenty four hours

Monaco

A four cell Horsfall destructor was erected here in 1898 the cells are of the top fed type and arranged back to back One water tube boiler having 75 square metres of heating surface is set in connection with the cells but the steam power is used for forced draught only The chimney is 35 metres in height and 1 30 metres internal diameter About thirty tons of refuse is destroyed daily

Paris (France)

In 1895 a small experimental destructor was erected at the Javal municipal workshops at a cost of about 25 000 francs The cells were of the modified Fryer type Although fairly satisfactory results were obtained the plant was not extended and to day Paris is still confronted with the refuse disposal problem

Zurich (Switzerland)

A twelve-cell Horsfall destructor has recently been erected the cells are of the top fed type and arranged back to back Two water tube boilers are provided and power is supplied for works purposes forced draught etc This installation is very similar to that at Brussels already described and illustrated

SOUTH AFRICA

Durban (Natal)

A four cell Warner destructor was erected here in 1899 a further destructor is likely to be erected very shortly

East London (Natal)

A four cell Warner destructor was erected here in 1900

Bloemfontein (Orange River Colony)

The municipality have recently decided to erect a small destructor of the Horsfall type

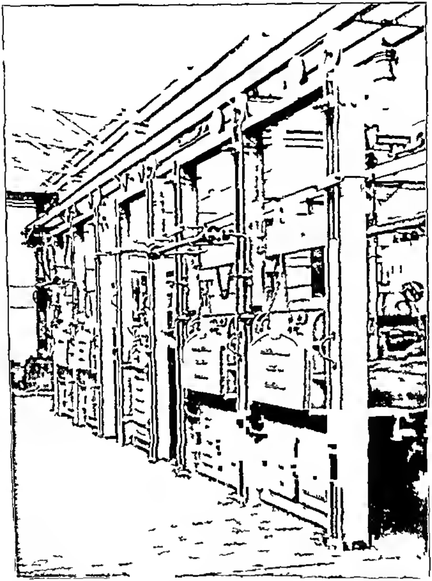


Fig. 9. J[illegible] D[illegible] F[illegible] 4 Cells

[illegible]

JOHANNESBURG (Transvaal)

A destructor of the Meldrum improved top-fed type is now being erected in this city. The plant comprises two four-grate

diameter During the year 1900 an average of 270,288 kilos of refuse was destroyed per twenty-four hours

Monaco

A four-cell Horsfall destructor was erected here in 1898; the cells are of the top fed type and arranged back to back One water tube boiler, having 75 square metres of heating surface, is set in connection with the cells, but the steam power is used for forced draught only The chimney is 35 metres in height, and 1 30 metres internal diameter About thirty tons of refuse is destroyed daily

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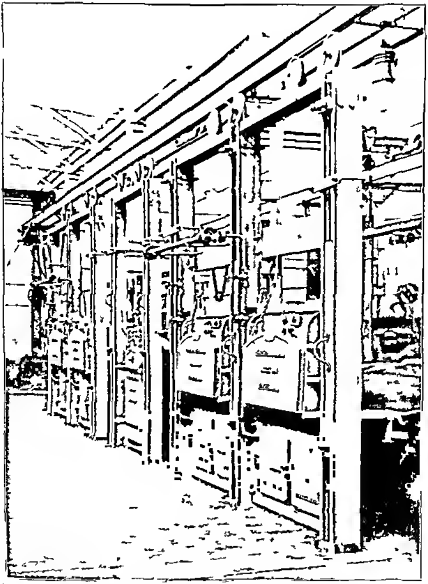

FIG 9 JOHANNESBURG DESTRUCTOR FURNACE IRONWORK FOR 4 CELLS
[illegible] Messrs Meldrum [illegible] Timperley

JOHANNESBURG (Transvaal)

A destructor of the Meldrum improved top fed type is now being erected in this city The plant comprises two four grate

unit destructors with regenerators for air heating and two Babcock & Wilcox boilers each having 1 966 square feet of heating surface The capacity of this the first modern destructor to be erected in South Africa is 120 tons daily and it is anticipated that a very useful amount of power will be produced therefrom for works purposes

Fig 97 is a view of the furnace fronts and ironwork in the maker s erecting shop prior to shipment

The destructor plant will be contained within an iron building and a sectional steel chimney 100 feet in height and 6 feet internal diameter lined with firebrick throughout will be erected

Under the Boer regime the question of refuse disposal was often discussed but such obstacles were always presented that it was found impossible to acquire a suitable site It is interesting to observe that at least one year before the conclusion of hostilities Major W A J O Meara R E was deputed to proceed to this country on behalf of the municipal council to investigate and report to the council concerning the progress made in Great Britain in final and sanitary refuse disposal The work now in progress is the direct outcome of Major O Meara s investigations and the startling and rapid change from the filthy methods previously in vogue augurs well for the future sanitary conditions of large South African municipalities

AUSTRALASIA

MELBOURNE (South)

A twelve cell Fryer destructor was erected here about eleven years since it is however reported that this is no longer used

MELBOURNE (Victoria)

A two cell Cracknell destructor was erected here some five years ago mainly for experimentary purposes Although favourably reported upon by the city surveyor the installation was not extended The Cracknell destructor was of Australian design and although capable of doing satisfactory work the temperature obtained was not sufficiently high

Toowoomba (Queensland)

Early in 1902 a two cell destructor of Meldrum's improved Beaman & Deas type was erected together with one Babcock and Wilcox boiler This destructor was specially designed for destroying excreta this material being destroyed with refuse in the proportion of three parts of excreta to one of refuse

The nature of the work being done by this destructor is probably without parallel anywhere it is nevertheless being successfully operated without offence although the chimney is but 40 feet in height

Being specially designed for the work required every possible provision was made for ensuring the constant exhaustion of all fumes through the fire Further careful provision is made for the easy cleansing of the containing hoppers it being essential that notwithstanding the nature of the work the building must be free from offence

Sydney (New South Wales)

A six cell Warner destructor was erected here in 1902

Annandale and Leichardt (Sydney New South Wales)

A destructor of the Meldrum Simplex type was erected here in 1902 and being the first of this type to be erected in the Antipodes much interest was centred upon its performance The installation is only a small one comprising a two grate unit destructor together with a regenerator for heating the air supply for combustion and a Cornish boiler The guaranteed destroying capacity of the plant was one ton per hour

The following report of the official test is of interest, this being conducted by Mr W M Gordon the city surveyor of Sydney

ANNANDALE AND LEICHHARDT GARBAGE DESTRUCTOR

REPORTS TO THE CITY COUNCIL ON A 48 HOURS' TEST

CITY SURVEYOR'S REPORT

I have the honour to report that a test has been made of the destructor known as the Meldrum Simplex, of two cells recently erected for the Annandale and Leichhardt Councils, for which purpose the City Council supplied garbage and had an officer present throughout the trial The work commenced at 4 p m on Tuesday, 28th and was completed at 4 p m on Thursday, 30th ult

The total amount of garbage consumed during the 48 hours was 60 tons 18 cwt 0 qrs 14 lbs made up as follows—

	Tons	Cwts	Qr	Lbs
City Council s Garbage	37	3	0	0
Annandale and Leichardt Council s Garbage	23	15	0	14

This is equal to 15 tons 4½ cwt per cell per 24 hours

The total residue was 24 tons 4 cwt 1 qr 24 lbs (equalling about 40 per cent of the whole) made up as follows—

	Tons	Cwts	Qrs	Lbs
Clinker	20	13	1	14
Ashes	3	11	0	10

The total cost of burning was £4 16s or 1s 6¾d per ton Care was taken that as nearly as possible the same class of garbage was sent to this destructor as to the Perfectus at Moore Park viz first loads at night early morning service and trade refuse and no complaints were received

The garbage from Annandale and Leichhardt was not good (especially the latter) as it contained a large percentage of dust burnt ashes and yard sweepings The loading on the 29th and 30th was very wet owing to the heavy rain and more difficult to burn More particularly does this apply to the garbage conveyed by the Annandale and Leichhardt carts which are uncovered

A feature of the destructor is that the garbage is all shovelled through the furnace doors and although I was at first not favourably impressed with the idea I am now convinced after demonstration that it is a marked improvement upon the dumping in of large quantities through hoppers over the furnaces

Steam is used for the forced draught and the temperature is very great and after experience with the Pinhoe and Perfectus I am convinced that a much higher degree of heat is obtained in the Simplex

There is no difficulty in keeping up steam as after the start, the steam never showed less than 65 lbs, and reached as high as 80 lbs

The destructor is worked with two men in three shifts of 8 hours

each and only two men out of the six men employed had had any previous experience in the work

The rate of wages paid is 8s per diem and consequently the cost is greater than it should be as—

The cost per ton (wages at 8s per diem) is	1s	6¾d
While „ „ „ „ 7s „ would be	1s	4½d

The whole of the residue was kept separate and unfortunately,

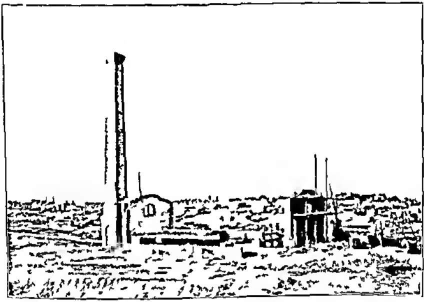

FIG 93 ANNANDALE (NEW SOUTH WALES) DESTRUCTOR IN COURSE OF ERECTION

was saturated with rain Therefore the trial may be said to be a severe one inasmuch as the garbage was wet and the weight of residue increased

Upon examination of the residue there can be little doubt about the completeness of the destruction and although exception might be taken to the clinker I am convinced that with the amount of dust and earthy matter it would be impossible to produce a much better clinker

During the trial the destructor was inspected by Dr Ashburton Thompson and the Medical Officer of Health for the Metropolis the latter of whom is making a complete report to the Board of Health

I am of opinion that the trial was in every way a most satisfactory one and the results will no doubt be gratifying to the two suburban Councils who are to be congratulated upon their combined efforts to cope with the destruction of garbage by fire

I have to express my thanks to Mr Hinsby, Council Clerk of Annandale for his ready and willing assistance

I have the honour to be Sir,

Your obedient servant

W M GORDON,

City Surveyor

P S —The cost of weighing and wages of Council's officers will be charged to the combined Councils an account of which will be forwarded

Fig 98 is an external view of the works, during course of erection

CHRISTCHURCH (New Zealand)

A destructor was erected here in 1901, comprising four cells of Meldrum's improved Beaman & Deas type, and two Babcock & Wilcox boilers this being the first modern high temperature destructor erected in the Antipodes It was not anticipated that any serious amount of power would be obtained from New Zealand refuse but in order to determine exactly what power was available exhaustive tests were made over extended periods with very satisfactory results

After thus demonstrating the possibilities of the destructor for power production the Council decided to instal the following electrical plant for public and private lighting—

Two Davey Paxman high speed three crank compound condensing engines and two Westinghouse 100 k w 250 volt compound wound D C engine type multipolar generators

Steam is supplied to the engines at a pressure of 150 pounds to the square inch The engines are mounted on extended base plates and direct coupled to the generators It was not anticipated by the destructor makers that sufficient power would be obtained from the refuse to warrant such a combination and such a case as this but serves to show that the production of power from refuse is not likely to be confined to Britain

WELLINGTON (New Zealand)

A six cell Fryer destructor was erected several years ago The Council now have under consideration several schemes for

a modern destructor and power plant and it is likely that a large new plant will be erected in the near future

INDIA

Calcutta

A four cell Horsfall destructor was erected here in 1891 Ten years later the municipality issued a specification inviting schemes and tenders from British destructor makers but the conditions embodied in the specification were such as to elicit but little response from destructor makers in this country It was eventually arranged to make a trial of the Baker destructor but as the installation has only recently been completed no information is yet available

Bombay

An experimentary destructor was erected some five years since by Messrs Garlick & Christenson of this city but the installation was not extended The authorities decided to reclaim some low lying land at Coorla and Devnur on the Great Indian Peninsular Railway where the refuse or *kutchra* of Bombay is now taken by rail at great expense to the municipality

Karachi

A six cell Warner destructor has been erected in this city

Madras

A twelve-cell Warner destructor was erected here several years since and more recently a small destructor of the Harrington type

THE FAR EAST

Singapore (Straits Settlements)

Two destructors have been erected here by Messrs Garlick & Christenson of Bombay a four cell plant at Jalan Besar and two cells at Tanjong Pagar

SHANGHAI (China)

At present the whole of the refuse is removed by water, the bulk of the material being used for manurial purposes

It is, however, anticipated that destructors will be installed within the next few years, and in view of this the following table, showing the component parts of Shanghai refuse for a whole year will doubtless be of interest (see page 367).

TABLE FROM REPORT OF THE SHANGHAI MUNICIPAL COUNCIL FOR YEAR ENDING DECEMBER 31, 1899 (MR CHAS MAYNE, ENGINEER AND SURVEYOR).

[1] Percentages by Weight of the Component parts of Shanghai Garbage for each month of the year, together with the Component Parts of Average London Garbage

Component Parts	Shanghai Garbage 1899												Average London Garbage
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Bricks and broken roof tiles	3 497	2 590	1 988	2 644	1 061	2 702	2 260	1 703	2 690	2 860	1 491	1 491	—
Cinders and ashes	27 339	31 257	30 530	27 544	17 167	21 697	12 841	12 224	11 503	10 213	9 972	8 530	69 69
Fine dust	45 245	40 791	42 409	40 798	37 204	43 789	47 830	35 588	31 790	34 511	35 050	32 785	19 51
Vegetable animal and various organic matter	15 776	14 750	14 304	17 551	34 121	18 092	23 795	37 745	45 925	44 006	45 552	50 098	4 61
Waste paper	546	564	385	410	435	509	3[illegible]9	220	108	242	182	212	4 24
Straw and fibrous material	8 102	8 694	9 251	9 667	8 004	11 822	11 973	9 340	7 283	7 100	6 749	5 916	3 [illegible]2
Bottles, unbroken	—	—	—	—	—	—	—	—	—	—	—	—	90
Coal and coke		—	—	—	—	—	—	—	—	—	—	—	84
Tins	539	433	292	257	259	232	237	216	122	239	179	223	79
Crockery	346	455	494	373	277	369	242	245	181	253	215	276	55
Bones	038	056	047	069	044	068	082	063	048	035	063	065	45
Broken glass	078	045	079	042	074	103	122	115	075	096	049	069	47
Rags	142	141	122	172	161	222	227	182	109	178	179	196	39
Iron	062	063	051	054	052	043	076	089	052	058	076	076	21
Wood	152	121	104	146	124	182	180	230	174	100	224	263	—
	100	100	100	100	100	100	100	100	100	100	100	100	100

Includes cabbage leaves, rinds of water melon and pumpkin, kholar, feathers, dead cats and dogs, putrid meat, old shoes, fish and fowl entrails, fish heads and bones, refuse from the manufacture of beancakes and Chinese sauce (soy), etc.

[1] The above figures were arrived at by taking a sample portion of garbage at random every day throughout the year, and the figures tabulated are a fair average.

Chapter XX

CONCLUDING REMARKS

The Destructor Chimney

WITH the introduction of forced draught and high temperature working it was at once evident that high chimneys would not be required Firstly, because the use of artificial draught under the grates would permit of high rates of combustion being reached and secondly, because the great increase in the combustion temperature ensured the discharge of inoffensive gases from the chimney

Needless to add the highest chimneys ever erected could not effect the same result as has been produced by means of the fan or steam jet blower and it is no exaggeration to state that under modern conditions a high chimney is a waste of money To erect a high chimney in connection with a good modern destructor is superfluous Owing to the unnecessarily high velocity of the gases with such chimneys there is a constant danger of discharging dust, and so in many cases where the layman insists upon a high chimney being erected, he does his level best to produce that very nuisance which he is most anxious to avoid

Fifteen years ago when the use of high chimneys was strongly advocated, nuisance was frequent, and fully as much annoyance was caused then by the discharge of dust as by the emission of offensive gases A high chimney was at that time necessary for purposes of draught production, now ample draught is secured independently of the chimney Offensive gases were then rightly discharged at a high altitude, now under high temperature conditions offensive gases are not liberated into the atmosphere

The high velocity necessary under the old conditions is now no longer required; actual experience has dictated the necessity for ensuring a low velocity, both in the flues and the chimney, and it has been demonstrated again and again that under modern conditions low chimneys can be used, being absolutely void of offence either from escaping fumes or dust

In modern practice it is found that a chimney of reasonable height having ample area fulfils all requirements, and many such chimneys have been erected amid such surroundings as permit of no nuisance whatever

The reader will have noted in the tabulated information that in the case of some few towns high chimneys have been erected within recent years In most cases the explanation will be found in the fact that coal fired boilers are also in use For instance, at a combined destructor and electricity works this is so, and it should not be forgotten that at a works of this kind the chimney has to be built of sufficient capacity to admit of additional coal fired boilers being installed as required over a number of years

In other cases sentimental reasons explain why a high chimney was erected, and, as already observed, many of those who have clamoured for the high chimney will yet be disillusioned when they notice the presence of dust

It is unnecessary to further discuss the chimney question here, the low chimney has been severely tested and has not been found wanting It has come to stay, and in itself it furnishes most conclusive evidence as to the excellence of the modern destructor

The Retention of Dust

As the result of a month's test at Nelson, Mr J A Priestley was able to show that the weight of the dust produced amounts to no less than 5 per cent by weight of the actual quantity of refuse charged into the destructor cell, and it may be assumed that this is a fair average

Being desirous of ascertaining exactly where the dust had been deposited and what proportions of the total quantity had been deposited at certain points, the destructor was cooled down at the end of a month's continuous run, the dust then being carefully

removed and weighed The result is seen in the following statement—

	Tons	cwt	qr
Fused dust from combustion chamber	17	11	0
Fused dust from bridge and roof of furnace	3	13	2
Dust from centre flues of boiler	0	7	1
Dust from under boiler i e flame bed	1	12	3
Dust from side flues of boiler	0	16	3
Dust from pit under regenerator	1	1	3
Dust from main flue	5	13	0
Total	30	16	0

These figures are of more than passing interest to the student clearly showing as they do exactly where the dust was deposited At Nelson the combustion chamber is placed at right angles to the cell as seen in fig 24 and it should be observed that the proportion of dust removed from the cells and combustion chamber amounted to rather more than two thirds of the total quantity It should also be noted that this proportion was *fused* This is an important point dust will only thus fuse by exposure to constant high temperature and fused dust is immovable i e all dust deposited in such a position that it fuses cannot then travel further

Ordinary dry dust accumulating at any point is constantly disturbed by the current of the gases but once fuse the accumulation and it becomes stationary The large proportion of dust deposited in the combustion chamber further serves to conclusively prove the efficiency of the combustion chamber as a dust catcher

Assuming that no combustion chamber were provided it must be obvious that a very large proportion of the dust would be deposited in the centre flues side flues and flame bed of the boiler the inevitable effect must be that the heating surface of the boiler would be covered and in the result the steam raising efficiency of the plant would be seriously reduced

It must be admitted that it is of great importance to secure the deposit of the bulk of the dust between the cells and the boiler, and not only for ensuring the efficient working of the boiler There is another and a powerful reason why the deposit

of dust should be definitely secured at an early stage in its travel to do so is to limit the risk A certain amount of dust must be produced if two thirds of the total quantity can be trapped immediately upon leaving the cell the balance to be deposited is not a serious quantity and it has a long way to travel before it can possibly escape

In the foregoing statement it will be observed that only a very small proportion of the dust was deposited in the internal and external flues of the boiler and further that over one ton of dust was deposited in the pit under the regenerator this is so far satisfactory because only a comparatively small quantity remains for deposition in the main flue beyond

Every system with which a combustion chamber is provided next to the cell offers a primary location for dust and it is impossible to over estimate the importance of this It should however, be borne in mind that the position of the combustion chamber in relation to the cell or cells is a factor of importance in so far as the efficiency of the combustion chamber is concerned

It is scarcely necessary to add that every destructor scheme should include definite means for securing the deposit of dust and as already observed the *earlier* the dust is deposited the better Under no circumstances may dust be permitted to escape from the chimney However satisfactory a destructor may be in other respects any discharge of dust is sufficiently serious to warrant the destructor being classed as a failure

It has already been pointed out that a low velocity of travel of the gases in the chimney is a desideratum this low velocity of travel is also of importance in the flues and to ensure the same the flues must be of ample area So much can be done in this simple way towards ensuring the deposit of dust that the method has been termed the common sense method'

Dust traps in the flues have been frequently tried but they are not often used in modern practice We may define modern methods as follows Firstly, the combustion chamber, which ensures the earliest possible deposit of dust and secondly, dust catchers or special dust collection chambers arranged at the chimney end of the main flue

That the dust catchers and collection chambers secure the deposit of dust will not be questioned, they are effective, and they answer the purpose for which they are erected It must however be remembered that a large proportion of dust must be deposited on the destructor side of the dust catcher—that is in the boiler flues and main flue This, as already observed is avoided with the early dust catcher—the combustion chamber—and therefore this system of dust trapping must be the more efficient of the two

The position of Horsfall's centrifugal dust catcher is illustrated in fig 87 It has been highly successful in arresting dust and has been extensively adopted but owing to its position it must be defined as a *late* dust catcher, being usually placed near to the chimney

This dust catcher consists of an outer annular chamber and an inner well The gases enter the outer chamber and swirl rapidly round it thereby throwing off the suspended dust against the outer wall The exit from the annular chamber is in the upper part leading into the inner chamber or well Here the gases have to pass downwards and an outlet is provided near the bottom leading to the chimney Cleaning doors are provided for removing the dust which accumulates in the pockets formed at the bottom of each chamber

As remarked already, the escape of dust from the chimney must be fatal to the record of any destructor, no matter how satisfactory the plant may be in other respects But it will be observed that in the case of a well designed installation the discharge of dust can be absolutely prevented

Automatic Checking Accessories

In the case of a combined works it is advisable that every possible check should be introduced with a view to maintaining the efficiency of the destructor Constant tests should be undertaken for the purpose of ascertaining how the temperature is maintained under normal working conditions, the data thus obtained will be found useful for determining the range of

fluctuation, and having reduced this to the minimum it should not be allowed to seriously vary.

Seeing that so much depends upon the temperature this is a matter of much importance, nevertheless but little has yet been done in this direction.

The temperature diagrams herein reproduced were obtained with a Callendar's electrical recording pyrometer, and although the hot dust carried in suspension in the gases has proved to be troublesome by settling on the thermometer tube, yet very satisfactory results have been obtained with this instrument.

Another valuable accessory which has been more extensively adopted is the constant steam pressure recorder, a most useful appliance, and one which is sure to be even more largely adopted in the future.

Every check of this kind upon the operations of the staff must be productive of good results. It is true that the working man possesses no great love for any mechanical contrivance which "tells tales," and no doubt the relentless pen leaving its impress on the chart is apt to be exasperating at times, but it affords a very necessary check upon the operation of the plant, and this is no more than those in authority are entitled to have.

A further important check is the periodical testing or analysis of the gases. The importance of this has already been fully discussed; it has also been remarked that with but few installations has conclusive proof been thus furnished that the combustion is perfect, or at any rate as near perfect as possible.

During the past few years, both in this country and on the Continent, the problem of combustion has been tackled in a more scientific manner than ever before, and it is now generally recognized that the efficiency of combustion must be determined by the percentage of CO_2 (carbon dioxide) in the gases.

In connection with the combustion of coal this test is becoming increasingly popular because it pays to secure the highest attainable efficiency. As it pays with coal so will it pay in the combustion of refuse, and it should not be forgotten that there are other reasons apart altogether from considerations of fuel

efficiency why the combustion process with the destructor should be above suspicion.

My closing remarks shall be addressed to those who have to make the choice of a destructor. To such the Author would make a few suggestions.

It should be remembered that when destructor makers are tendering for the supply and erection of a destructor, each maker is offering his own specialty. It is not a case for comparison with the aid of the quantity surveyor as to the relative cubic capacity of the cell, the number of rods of brickwork, or tons of ironwork. The relative value of two entirely different destructors cannot be ascertained in this way.

Schemes and tenders can only be reasonably compared after careful scrutiny by one competent to analyse each scheme, and needless to add such work should be undertaken by the permanent official—the engineer and surveyor.

Obvious as this must be, yet the energetic councillor would often take upon himself the task of choosing between various schemes, and frequently being devoid of technical knowledge he is to a serious extent influenced by the price—a factor which while being of some importance very often offers the loophole for the selection of an experimentary plant.

Municipalities have no right to spend public money on experimentary installations. It is clearly the duty of a municipality to make close investigation, and to ensure the best possible investment for the ratepayers. In the case of destructors it will have been observed by the reader that not only are there many types greatly differing in design, but the difference in efficiency is often as marked as the difference in design. Again, there is a very wide difference in the labour cost, the area of ground necessary for erection, and the height of the chimney suggested.

In a paper[1] read at the Exeter Congress of the Royal Institute

[1] *Recent Practice in Refuse Disposal and Utilisation Plants.* By Mr Frank Watson. Royal Institute of Public Health, Exeter Congress, August 1902.

of Public Health, last year, Mr Frank Watson clearly stated the case for the destructor maker, and his remarks, which are here quoted *in extenso*, are worthy of careful perusal

It must be borne in mind that when tenders are invited for refuse disposal plant each patentee is offering his own specialty the conditions are therefore totally different from those which obtain when an engineer or architect issues a set of drawings and quantities for a building or a sewer or a new road It may easily happen that the firm which asks the highest price is giving much greater proportionate value than the firm which asks the lowest and that if the lowest tender be accepted the contractor will make a greater profit than would the contractor who sends in the highest tender provided always that the contractor succeeds in fulfilling his guarantees and getting paid for his plant It is a not uncommon error to suppose that the firm which offers the highest pecuniary penalty in case of failure is the most reliable The inventor, however is proverbially sanguine and in attempting to introduce a new and untried scheme will usually agree to any conditions which may be proposed in order to get the scheme adopted his faith in his own inventions being in inverse ratio to his experience of their results Complicated mechanisms designed to save labour are frequently brought forward in connection with these plants It should always be remembered that the conditions under which a destructor works are all against the success of mechanical arrangements situated within the furnace Every appliance whether for opening or closing doors producing the necessary forced draught or charging or clinkering the furnace should be of the simplest and most direct character An apparent economy is often entirely discounted by the cost of maintenance and what is still more serious by the stoppage of the works during repairs

So many destructors are now in operation in this country under such a variety of conditions that it is possible for most intending purchasers to inspect quite a number of installations working under conditions practically the same as will obtain in their own case Such are the installations to inspect and critically compare It is useless to attempt to get an adequate idea of what a two cell plant would be by inspecting a ten-cell plant, nor is it reasonable to compare a plant erected fifteen years ago with one of a modern character

It may be fairly submitted that the best modern destructors are highly satisfactory, that they may be erected in the most central positions without fear of nuisance that they fulfil their

primary object perfectly, and lastly, that a very useful amount of power can be produced To utilize such power for the best interests of the community should be the aim of those in authority. Wherever the available power will yield the best return for the ratepayers there should it be utilized

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diameter During the year 1900 an average of 270 288 kilos of refuse was destroyed per twenty four hours

Monaco

A four cell Horsfall destructor was erected here in 1898, the cells are of the top fed type and arranged back to back One water tube boiler having 75 square metres of heating surface is set in connection with the cells but the steam power is used for forced draught only The chimney is 35 metres in height and 1 30 metres internal diameter About thirty tons of refuse is destroyed daily

Paris (France)

In 1895 a small experimental destructor was erected at the Javal municipal workshops at a cost of about 25 000 francs The cells were of the modified Fryer type Although fairly satisfactory results were obtained the plant was not extended and to day Paris is still confronted with the refuse disposal problem

Zurich (Switzerland)

A twelve-cell Horsfall destructor has recently been erected the cells are of the top fed type and arranged back to back Two water tube boilers are provided and power is supplied for works purposes forced draught etc This installation is very similar to that at Brussels already described and illustrated

SOUTH AFRICA

Durban (Natal)

A four-cell Warner destructor was erected here in 1899 a further destructor is likely to be erected very shortly

East London (Natal)

A four cell Warner destructor was erected here in 1900

Bloemfontein (Orange River Colony)

The municipality have recently decided to erect a small destructor of the Horsfall type

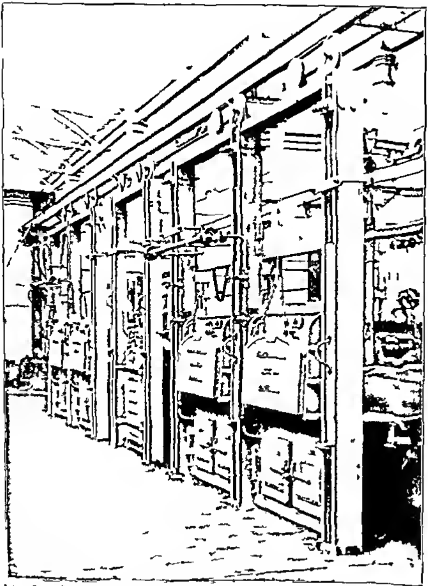

Fig. 9. Johannesburg Destructor. Furnace Ironwork for 4 Cells

Lent by Messrs. Meldrum's Shops, Timperley

Johannesburg (Transvaal)

A destructor of the Meldrum improved top fed type is now being erected in this city. The plant comprises two four grate

unit destructors with regenerators for air heating, and two Babcock & Wilcox boilers, each having 1,966 square feet of heating surface The capacity of this the first modern destructor to be erected in South Africa is 120 tons daily, and it is anticipated that a very useful amount of power will be produced therefrom for works purposes

Fig 97 is a view of the furnace fronts and ironwork in the maker's erecting shop prior to shipment

The destructor plant will be contained within an iron building, and a sectional steel chimney, 100 feet in height and 6 feet internal diameter lined with firebrick throughout, will be erected

Under the Boer regime the question of refuse disposal was often discussed but such obstacles were always presented that it was found impossible to acquire a suitable site It is interesting to observe that at least one year before the conclusion of hostilities Major W A J O'Meara R E was deputed to proceed to this country on behalf of the municipal council to investigate and report to the council concerning the progress made in Great Britain in final and sanitary refuse disposal The work now in progress is the direct outcome of Major O'Meara's investigations, and the startling and rapid change from the filthy methods previously in vogue augurs well for the future sanitary conditions of large South African municipalities

AUSTRALASIA

MELBOURNE (South)

A twelve-cell Fryer destructor was erected here about eleven years since, it is, however, reported that this is no longer used

MELBOURNE (Victoria)

A two cell Cracknell destructor was erected here some five years ago mainly for experimentary purposes Although favourably reported upon by the city surveyor, the installation was not extended The Cracknell destructor was of Australian design, and, although capable of doing satisfactory work, the temperature obtained was not sufficiently high

Toowoomba (Queensland)

Early in 1902 a two cell destructor of Meldrum's improved Beaman & Deas type was erected together with one Babcock and Wilcox boiler This destructor was specially designed for destroying excreta this material being destroyed with refuse, in the proportion of three parts of excreta to one of refuse

The nature of the work being done by this destructor is probably without parallel anywhere it is nevertheless being successfully operated without offence although the chimney is but 40 feet in height

Being specially designed for the work required every possible provision was made for ensuring the constant exhaustion of all fumes through the fire Further careful provision is made for the easy cleansing of the containing hoppers it being essential that notwithstanding the nature of the work the building must be free from offence

Sydney (New South Wales)

A six cell Warner destructor was erected here in 1902

Annandale and Leichardt (Sydney New South Wales)

A destructor of the Meldrum Simplex type was erected here in 1902 and being the first of this type to be erected in the Antipodes much interest was centred upon its performance The installation is only a small one comprising a two-grate unit destructor together with a regenerator for heating the air supply for combustion and a Cornish boiler The guaranteed destroying capacity of the plant was one ton per hour

The following report of the official test is of interest this being conducted by Mr W M Gordon the city surveyor of Sydney

ANNANDALE AND LEICHHARDT GARBAGE DESTRUCTOR

Reports to the City Council on a 48 hours' Test

City Surveyor's Report

I have the honour to report that a test has been made of the destructor known as the Meldrum Simplex, of two cells, recently erected for the Annandale and Leichhardt Councils, for which purpose the City Council supplied garbage, and had an officer present throughout the trial The work commenced at 4 p m on Tuesday, 28th, and was completed at 4 p m on Thursday, 30th ult

The total amount of garbage consumed during the 48 hours was 60 tons 18 cwt 0 qrs 14 lbs, made up as follows—

	Tons	Cwts	Qrs	Lbs
City Council s Garbage	37	3	0	0
Annandale and Leichardt Council s Garbage	23	15	0	14

This is equal to 15 tons 4½ cwt per cell per 24 hours

The total residue was 24 tons 4 cwt 1 qr 24 lbs (equalling about 40 per cent of the whole), made up as follows—

	Tons	Cwts	Qrs	Lbs
Clinker	20	13	1	14
Ashes	3	11	0	10

The total cost of burning was £4 16s, or 1s 6¾d per ton Care was taken that as nearly as possible the same class of garbage was sent to this destructor as to the Perfectus at Moore Park viz first loads at night early morning service and trade refuse, and no complaints were received

The garbage from Annandale and Leichhardt was not good (especially the latter) as it contained a large percentage of dust burnt ashes and yard sweepings The loading on the 29th and 30th was very wet owing to the heavy rain, and more difficult to burn More particularly does this apply to the garbage conveyed by the Annandale and Leichhardt carts, which are uncovered

A feature of the destructor is that the garbage is all shovelled through the furnace doors and although I was at first not favourably impressed with the idea, I am now convinced after demonstration that it is a marked improvement upon the dumping in of large quantities through hoppers over the furnaces

Steam is used for the forced draught, and the temperature is very great, and, after experience with the Pinhoe and Perfectus, I am convinced that a much higher degree of heat is obtained in the Simplex

There is no difficulty in keeping up steam, as after the start, the steam never showed less than 65 lbs, and reached as high as 80 lbs

The destructor is worked with two men in three shifts of 8 hours

each, and only two men out of the six men employed had had any previous experience in the work

The rate of wages paid is 8s per diem, and consequently the cost is greater than it should be as—

The cost per ton (wages at 8s per diem) is		1s 6¾d
While „ „ „ „ 7s „ would be		1s 4½d

The whole of the residue was kept separate, and unfortunately,

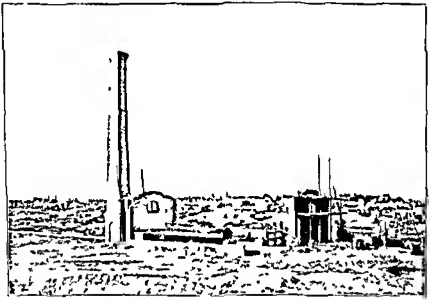

FIG 93 ANNANDALE (NEW SOUTH WALES) DESTRUCTOR IN COURSE OF ERECTION

was saturated with rain Therefore, the trial may be said to be a severe one, inasmuch as the garbage was wet and the weight of residue increased

Upon examination of the residue, there can be little doubt about the completeness of the destruction, and although exception might be taken to the clinker, I am convinced that with the amount of dust and earthy matter it would be impossible to produce a much better clinker.

During the trial the destructor was inspected by Dr. Ashburton Thompson and the Medical Officer of Health for the Metropolis, the latter of whom is making a complete report to the Board of Health.

I am of opinion that the trial was in every way a most satisfactory one, and the results will no doubt be gratifying to the two suburban Councils, who are to be congratulated upon their combined efforts to cope with the destruction of garbage by fire

I have to express my thanks to Mr Hinds, Council Clerk of Annandale, for his ready and willing assistance.

I have the honour to be Sir,
Your obedient servant,
W. M. Gordon,
City Surveyor.

P.S.—The cost of weighing and wages of Councils' officers will be charged to the combined Councils, an account of which will be forwarded.

Fig. 98 is an external view of the works during course of erection.

Christchurch (New Zealand)

A destructor was erected here in 1901, comprising four cells of Meldrum's improved Beaman & Deas type, and two Babcock & Wilcox boilers, this being the first modern high temperature destructor erected in the Antipodes. It was not anticipated that any serious amount of power would be obtained from New Zealand refuse, but in order to determine exactly what power was available exhaustive tests were made over extended periods with very satisfactory results.

After thus demonstrating the possibilities of the destructor for power production, the Council decided to install the following electrical plant for public and private lighting:—

Two Davey Paxman high speed three-crank compound condensing engines, and two Westinghouse 100 k.w. 250 volt compound wound D.C. engine type multipolar generators.

Steam is supplied to the engines at a pressure of 150 pounds to the square inch. The engines are mounted on extended base plates and direct coupled to the generators. It was not anticipated by the destructor makers that sufficient power would be obtained from the refuse to warrant such a combination, and such a case as this but serves to show that the production of power from refuse is not likely to be confined to Britain.

Wellington (New Zealand)

A six-cell Fryer destructor was erected several years ago. The Council now have under consideration several schemes for

a modern destructor and power plant and it is likely that a large new plant will be erected in the near future

INDIA.

CALCUTTA

A four cell Horsfall destructor was erected here in 1891 Ten years later the municipality issued a specification inviting schemes and tenders from British destructor makers, but the conditions embodied in the specification were such as to elicit but little response from destructor makers in this country It was eventually arranged to make a trial of the *Baker* destructor, but as the installation has only recently been completed no information is yet available

BOMBAY

An experimentary destructor was erected some five years since by Messrs Garlick & Christenson of this city but the installation was not extended The authorities decided to reclaim some low lying land at Coorla and Devnur, on the Great Indian Peninsular Railway where the refuse or *Kutchra* of Bombay is now taken by rail, at great expense to the municipality

KARACHI

A six-cell Warner destructor has been erected in this city

MADRAS

A twelve-cell Warner destructor was erected here several years since, and more recently a small destructor of the Harrington type

THE FAR EAST

SINGAPORE (Straits Settlements)

Two destructors have been erected here by Messrs Garlick & Christenson of Bombay, a four-cell plant at Jalan Besar, and two cells at Tanjong Pagar

Shanghai (China)

At present the whole of the refuse is removed by water, the bulk of the material being used for manurial purposes

It is, however, anticipated that destructors will be installed within the next few years, and in view of this the following table, showing the component parts of Shanghai refuse for a whole year will doubtless be of interest (see page 367)

TABLE FROM REPORT OF THE SHANGHAI MUNICIPAL COUNCIL FOR YEAR ENDING DECEMBER 31, 1899 (MR. CHAS. MAYNE, ENGINEER AND SURVEYOR)

* Percentages by Weight of the Component parts of Shanghai Garbage for each month of the year, together with the Component Parts of Average London Garbage

Component Parts	Shanghai Garbage 1899												Average London Garbage
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Bricks and broken roof tiles	3 407	2 500	1 928	2 644	1 961	2 702	2 260	1 703	2 640	2 600	1 441	1 491	—
Cinders and ashes	27 314	31 257	30 370	27 344	17 167	21 697	13 841	12 224	11 303	19 213	9 972	6 330	69 69
Fine dust	45 243	40 791	42 400	40 798	37 404	43 749	47 030	35 588	31 700	34 511	35 050	32 785	19 51
Vegetable animal and other organic matter *	13 776	14 750	14 304	17 551	34 121	18 092	23 785	37 745	45 025	41 008	46 662	50 098	4 61
Waste paper	546	564	345	410	435	509	359	229	108	242	182	212	4 29
Straw and packing material	8 102	8 694	9 251	9 667	8 004	11 822	11 973	9 349	7 243	7 100	6 749	5 916	3 22
Bottles, unbroken	—	—	—	—	—	—	—	—	—	—	—	—	16
Coal and coke	—	—	—			—		—	—	—	—	—	84
Tins	314	433	292	257	259	242	227	216	122	238	179	223	79
Crockery	346	455	494	373	277	369	242	245	181	253	315	276	55
Bones	058	056	047	069	088	088	062	063	048	055	063	065	44
Broken glass	078	043	070	042	074	103	122	115	075	096	088	060	47
Rags	182	141	122	172	161	222	247	182	160	178	179	106	39
Iron	062	063	051	059	052	043	076	089	052	058	076	076	21
Wood	152	121	108	146	128	182	186	230	174	190	224	263	—
	100	100	100	100	100	100	100	100	100	100	100	100	100

* Includes cabbage leaves, rinds of water melon and pumpkin, [illegible] feathers, dead cats and dogs, putrid meat, old shoes, fish and fowl entrails, fish heads and bones, refuse from the manufacture of beancakes and Chinese sauce (soy), etc.

* The above figures were arrived at by taking a sample cartload of garbage at random every day throughout the year and the figures tabulated are a fair average

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Component Parts	Shanghai Garbage 1899 Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Average London Garbage
Bricks and broken roof tiles	3 407	2 500	1 929	2 644	1 961	2 702	2 260	1 703	2 090	2 800	1 481	1 401	—
Cinders and ashes	27 334	31 257	30 530	27 544	17 167	21 097	12 841	12 224	11 301	10 213	9 072	8 330	60 60
Fine dust	45 285	40 701	42 409	40 704	37 204	41 749	47 640	35 548	31 790	34 511	35 050	32 785	19 51
Vegetable animal and various organic matter*	13 [illegible]	14 750	14 304	17 551	34 121	14 002	23 783	37 745	45 925	44 096	45 552	50 038	4 01
Waste paper	516	564	385	410	435	309	3[illegible]9	2[illegible]0	108	242	182	212	4 24
Straw and fibrous material	8 102	8 694	9 251	9 007	8 094	11 8[illegible]2	11 073	9 340	7 283	7 100	6 749	5 910	3 [illegible]2
Bottles, unbroken	—	—	—		—	—		—		—	—	—	16
Coal and coke	—	—	—	—						—	—	—	84
Tins	534	433	292	257	259	242	2[illegible]7	216	122	294	179	227	70
Crockery	346	455	404	373	2[illegible]7	309	242	245	181	251	215	270	55
Bones	0[illegible]4	056	047	069	044	044	062	063	048	055	067	065	48
Broken glass	079	045	079	042	074	103	122	115	075	096	044	069	47
Rags	182	141	122	172	161	22[illegible]	227	182	180	178	170	100	39
Iron	062	063	051	058	052	043	078	080	052	058	078	078	21
Wood	152	121	104	146	1[illegible]4	142	180	230	174	390	224	203	—
	100	100	100	100	100	100	100	100	100	100	100	100	100

* Includes cabbage leaves, rinds of water melon and pumpkin, skin of ar..., feathers, dead cats and dogs, putrid meat, old shoes, fish and fowl entrails, fish heads and bones, refuse from the manufacture of bean cakes and Chinese sauce (soy), etc.

† The above figures were arrived at by taking a sample cartload of garbage at random every day throughout the year and the figures tabulated are a fair average.

Chapter XX

CONCLUDING REMARKS

THE DESTRUCTOR CHIMNEY

WITH the introduction of forced draught and high temperature working it was at once evident that high chimneys would not be required Firstly, because the use of artificial draught under the grates would permit of high rates of combustion being reached and secondly because the great increase in the combustion temperature ensured the discharge of inoffensive gases from the chimney

Needless to add the highest chimneys ever erected could not effect the same result as has been produced by means of the fan or steam jet blower and it is no exaggeration to state that under modern conditions a high chimney is a waste of money To erect a high chimney in connection with a good modern destructor is superfluous Owing to the unnecessarily high velocity of the gases with such chimneys there is a constant danger of discharging dust and so in many cases where the layman insists upon a high chimney being erected he does his level best to produce that very nuisance which he is most anxious to avoid

Fifteen years ago when the use of high chimneys was strongly advocated, nuisance was frequent and fully as much annoyance was caused then by the discharge of dust as by the emission of offensive gases A high chimney was at that time necessary for purposes of draught production, now ample draught is secured independently of the chimney Offensive gases were then rightly discharged at a high altitude now under high temperature conditions offensive gases are not liberated into the atmosphere

The high velocity necessary under the old conditions is now no longer required actual experience has dictated the necessity for ensuring a low velocity both in the flues and the chimney and it has been demonstrated again and again that under modern conditions low chimneys can be used being absolutely void of offence either from escaping fumes or dust

In modern practice it is found that a chimney of reasonable height having ample area fulfils all requirements and many such chimneys have been erected amid such surroundings as permit of no nuisance whatever

The reader will have noted in the tabulated information that in the case of some few towns high chimneys have been erected within recent years In most cases the explanation will be found in the fact that coal fired boilers are also in use For instance at a combined destructor and electricity works this is so and it should not be forgotten that at a works of this kind the chimney has to be built of sufficient capacity to admit of additional coal fired boilers being installed as required over a number of years

In other cases sentimental reasons explain why a high chimney was erected and as already observed many of those who have clamoured for the high chimney will yet be disillusioned when they notice the presence of dust

It is unnecessary to further discuss the chimney question here, the low chimney has been severely tested and has not been found wanting It has come to stay and in itself it furnishes most conclusive evidence as to the excellence of the modern destructor

The Retention of Dust

As the result of a month's test at Nelson Mr J A Priestley was able to show that the weight of the dust produced amounts to no less than 5 per cent by weight of the actual quantity of *refuse charged into the destructor cell and it may be assumed* that this is a fair average

Being desirous of ascertaining exactly where the dust had been deposited and what proportions of the total quantity had been deposited at certain points the destructor was cooled down at the end of a month's continuous run the dust then being carefully

removed and weighed The result is seen in the following statement—

	Tons	cwt	qr
Fused dust from combustion chamber	17	11	0
Fused dust from bridge, and roof of furnace	3	13	2
Dust from centre flues of boiler	0	7	1
Dust from under boiler, i e flame bed	1	12	3
Dust from side flues of boiler	0	16	3
Dust from pit under regenerator	1	1	3
Dust from main flue	5	13	0
Total	30	16	0

These figures are of more than passing interest to the student, clearly showing as they do exactly where the dust was deposited At Nelson the combustion chamber is placed at right angles to the cell as seen in fig 24, and it should be observed that the proportion of dust removed from the cells and combustion chamber amounted to rather more than two thirds of the total quantity It should also be noted that this proportion was *fused* This is an important point, dust will only thus fuse by exposure to constant high temperature, and fused dust is unmovable, i e all dust deposited in such a position that it fuses cannot then travel further

Ordinary dry dust accumulating at any point is constantly disturbed by the current of the gases, but once fuse the accumulation and it becomes stationary The large proportion of dust deposited in the combustion chamber further serves to conclusively prove the efficiency of the combustion chamber as a dust catcher

Assuming that no combustion chamber were provided, it must be obvious that a very large proportion of the dust would be deposited in the centre flues, side flues and flame bed of the boiler, the inevitable effect must be that the heating surface of the boiler would be covered, and in the result the steam raising efficiency of the plant would be seriously reduced

It must be admitted that it is of great importance to secure the deposit of the bulk of the dust between the cells and the boiler, and not only for ensuring the efficient working of the boiler. There is another and a powerful reason why the deposit

of dust should be definitely secured at an early stage in its travel to do so is to limit the risk A certain amount of dust must be produced, if two-thirds of the total quantity can be trapped immediately upon leaving the cell the balance to be deposited is not a serious quantity and it has a long way to travel before it can possibly escape

In the foregoing statement it will be observed that only a very small proportion of the dust was deposited in the internal and external flues of the boiler and further that over one ton of dust was deposited in the pit under the regenerator this is so far satisfactory because only a comparatively small quantity remains for deposition in the main flue beyond

Every system with which a combustion chamber is provided next to the cell offers a primary location for dust and it is impossible to over estimate the importance of this It should however be borne in mind that the position of the combustion chamber in relation to the cell or cells is a factor of importance in so far as the efficiency of the combustion chamber is concerned

It is scarcely necessary to add that every destructor scheme should include definite means for securing the deposit of dust and as already observed the *earlier* the dust is deposited the better Under no circumstances may dust be permitted to escape from the chimney However satisfactory a destructor may be in other respects any discharge of dust is sufficiently serious to warrant the destructor being classed as a failure

It has already been pointed out that a low velocity of travel of the gases in the chimney is a desideratum this low velocity of travel is also of importance in the flues and to ensure the same the flues must be of ample area So much can be done in this simple way towards ensuring the deposit of dust that the method has been termed the common sense method"

Dust traps in the flues have been frequently tried but they are not often used in modern practice We may define modern methods as follows Firstly, the combustion chamber, which ensures the earliest possible deposit of dust, and secondly, dust catchers or special dust collection chambers arranged at the chimney end of the main flue

That the dust catchers and collection chambers secure the deposit of dust will not be questioned they are effective and they answer the purpose for which they are erected It must however be remembered that a large proportion of dust must be deposited on the destructor side of the dust catcher—that is in the boiler flues and main flue This as already observed is avoided with the early dust catcher—the combustion chamber—and therefore this system of dust trapping must be the more efficient of the two

The position of Horsfall's centrifugal dust catcher is illustrated in fig 87 It has been highly successful in arresting dust and has been extensively adopted but owing to its position it must be defined as a *late* dust catcher being usually placed near to the chimney

This dust catcher consists of an outer annular chamber and an inner well The gases enter the outer chamber and swirl rapidly round it thereby throwing off the suspended dust against the outer wall The exit from the annular chamber is in the upper part leading into the inner chamber or well Here the gases have to pass downwards and an outlet is provided near the bottom leading to the chimney Cleaning doors are provided for removing the dust which accumulates in the pockets formed at the bottom of each chamber

As remarked already the escape of dust from the chimney must be fatal to the record of any destructor no matter how satisfactory the plant may be in other respects But it will be observed that in the case of a well designed installation the discharge of dust can be absolutely prevented

Automatic Checking Accessories

In the case of a combined works it is advisable that every possible check should be introduced with a view to maintaining the efficiency of the destructor Constant tests should be undertaken for the purpose of ascertaining how the temperature is maintained under normal working conditions the data thus obtained will be found useful for determining the range of

fluctuation, and having reduced this to the minimum it should not be allowed to seriously vary

Seeing that so much depends upon the temperature this is a matter of much importance nevertheless but little has yet been done in this direction

The temperature diagrams herein reproduced were obtained with a Callendar's electrical recording pyrometer and although the hot dust carried in suspension in the gases has proved to be troublesome by settling on the thermometer tube yet very satisfactory results have been obtained with this instrument

Another valuable accessory which has been more extensively adopted is the constant steam pressure recorder a most useful appliance and one which is sure to be even more largely adopted in the future

Every check of this kind upon the operations of the staff must be productive of good results It is true that the working man possesses no great love for any mechanical contrivance which tells tales and no doubt the relentless pen leaving its impress on the chart is apt to be exasperating at times but it affords a very necessary check upon the operation of the plant and this is no more than those in authority are entitled to have

A further important check is the periodical testing or analysis of the gases The importance of this has already been fully discussed it has also been remarked that with but few installations has conclusive proof been thus furnished that the combustion is perfect or at any rate as near perfect as possible

During the past few years both in this country and on the Continent the problem of combustion has been tackled in a more scientific manner than ever before and it is now generally recognized that the efficiency of combustion must be determined by the percentage of CO_2 (carbon dioxide) in the gases

In connection with the combustion of coal this test is becoming increasingly popular because it pays to secure the highest attainable efficiency As it pays with coal so will it pay in the combustion of refuse and it should not be forgotten that there are other reasons apart altogether from considerations of fuel

efficiency why the combustion process with the destructor should be above suspicion

My closing remarks shall be addressed to those who have to make the choice of a destructor. To such the Author would make a few suggestions.

It should be remembered that when destructor makers are tendering for the supply and erection of a destructor, each maker is offering his own speciality. It is not a case for comparison with the aid of the quantity surveyor as to the relative cubic capacity of the cells, the number of rods of brickwork or tons of ironwork. The relative value of two entirely different destructors cannot be ascertained in this way.

Schemes and tenders can only be reasonably compared after careful scrutiny by one competent to analyse each scheme and, needless to add, such work should be undertaken by the permanent official—the engineer and surveyor.

Obvious as this must be, yet the energetic councillor would often take upon himself the task of choosing between various schemes and, frequently being devoid of technical knowledge, he is to a serious extent influenced by the price—a factor which, while being of some importance, very often offers the loophole for the selection of an experimentary plant.

Municipalities have no right to spend public money on experimentary installations. It is clearly the duty of a municipality to make close investigation and to ensure the best possible investment for the ratepayers. In the case of destructors it will have been observed by the reader that not only are there many types greatly differing in design, but the difference in efficiency is often as marked as the difference in design. Again, there is a very wide difference in the labour cost, the area of ground necessary for erection, and the height of the chimney suggested.

In a paper[1] read at the Exeter Congress of the Royal Institute

[1] *Recent Practice in Refuse Disposal and Utilisation Plants.* By Mr Frank Watson, Royal Institute of Public Health, Exeter Congress, August 1902.

of Public Health, last year, Mr Frank Watson clearly stated the case for the destructor maker, and his remarks, which are here quoted *in extenso*, are worthy of careful perusal

It must be borne in mind that when tenders are invited for refuse disposal plant each patentee is offering his own specialty, the conditions are, therefore totally different from those which obtain when an engineer or architect issues a set of drawings and quantities for a building or a sewer or a new road It may easily happen that the firm which asks the highest price is giving much greater proportionate value than the firm which asks the lowest and that if the lowest tender be accepted the contractor will make a greater profit than would the contractor who sends in the highest tender provided always that the contractor succeeds in fulfilling his guarantees and getting paid for his plant It is a not uncommon error to suppose that the firm which offers the highest pecuniary penalty in case of failure is the most reliable The inventor, however, is proverbially sanguine and in attempting to introduce a new and untried scheme will usually agree to any conditions which may be proposed in order to get the scheme adopted his faith in his own inventions being in inverse ratio to his experience of their results Complicated mechanisms designed to save labour are frequently brought forward in connection with these plants It should always be remembered that the conditions under which a destructor works are all against the success of mechanical arrangements situated within the furnace Every appliance whether for opening or closing doors producing the necessary forced draught or charging or clinkering the furnace should be of the simplest and most direct character An apparent economy is often entirely discounted by the cost of maintenance and what is still more serious by the stoppage of the works during repairs

So many destructors are now in operation in this country under such a variety of conditions that it is possible for most intending purchasers to inspect quite a number of installations working under conditions practically the same as will obtain in their own case Such are the installations to inspect and critically compare It is useless to attempt to get an adequate idea of what a two cell plant would be by inspecting a ten cell plant, nor is it reasonable to compare a plant erected fifteen years ago with one of a modern character

It may be fairly submitted that the best modern destructors are highly satisfactory, that they may be erected in the most central positions without fear of nuisance that they fulfil their

primary object perfectly, and lastly, that a very useful amount of power can be produced To utilize such power for the best interests of the community should be the aim of those in authority. Wherever the available power will yield the best return for the ratepayers there should it be utilized

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